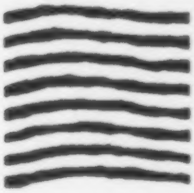
MINERAL REPORT No. 38

1989

CANADIAN MINERALS YEARBOOK



REVIEW AND OUTLOOK

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Foreword

Each year, Energy, Mines and Resources Canada completes a comprehensive review of developments in the minerals and metals sector and publishes the results as the Canadian Minerals Yearbook. The subject matter spans all aspects of the sector from geoscience and exploration, through mining and processing, to markets, consumption and recycling. Although domestic developments receive the greatest attention, international items are also reviewed because of the worldwide interrelationship that is characteristic of this sector. Some chapters of this publication are intended to be general enough to be of interest to a broad readership, while others are more technical and will largely appeal to individuals who are directly or closely associated with the industry.

The Canadian Minerals Yearbook series forms a continuous record from year to year. Generally, the basic industry indicators are comparable from one year to the next, but format and focus may shift over time. An example is the prominence given to trade and markets in the current commodity chapters. In earlier times, commodity markets were mainly supply driven; they are now largely demand driven.

The ups and downs of the industry, which have been especially pronounced during the past decade, have been leading factors in determining content in the Yearbook. At one point, many analysts began to view the minerals and metals sector as a sunset industry. This prognostication appears to have been premature as the value of production for the sector recovered to $39.1 billion in 1989, representing 4.5% of the economy and accounting for an impressive 23% of Canada's merchandise exports. Clearly, the industry will remain a cornerstone of the Canadian economy for some time to come.

Although the minerals and metals industry successfully managed to readjust to some very fundamental changes in the 1980s, there is evidence that more change will be needed in the next decade. The environment, free trade and globalization have already appeared as leading issues for the 1990s. Fortunately, the minerals and metals industry is as well prepared to manage and take advantage of the challenges and opportunities arising from these and other issues as at any other time in its history.

This edition of the Yearbook reports on the activity of the minerals and metals industry during 1989. The leading chapter is a general review, that identifies the predominant economic events of 1989 and indicates the major trends in the Canadian economy. It also covers the general developments and overall patterns of the mineral industry during the year. This is followed by chapters on the regional and international scenes, labour and employment, mine reserves, development and promising deposits, and mineral exploration. The 36 commodity chapters - the work of the Mineral and Metal Commodities Branch of the Mineral Policy Sector and the Uranium and Nuclear Energy Branch of the Energy Sector - feature economic and policy developments, markets, prices, trade, production and consumption data specific to each commodity. The outlook section under each commodity review provides a forecast of the industry's future position.

The basic statistics on Canadian production, trade and consumption, unless otherwise stated, were collected by the Mineral and Metal Statistics Division, Mineral Policy Sector, and by Statistics Canada. Market quotations were taken mainly from standard marketing reports. Corporate data were obtained directly from company officials through surveys or correspondence, or were extracted from annual reports. Energy, Mines and Resources Canada is grateful to all those who contributed information used in the preparation of this report.

Additional copies of the Yearbook can be purchased from the Canadian Government Publishing Centre (613) 956-4802 and associated bookstores. Previous editions of the Canadian Minerals Yearbook have been deposited in various libraries across Canada.

Reprints of individual chapters and Map 900A, Principal Mineral Areas of Canada, may be obtained free of charge from:

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PLEASE NOTE :

- *The figures depicted on page* **7.27** *and page* **34.18** *should be interchanged.*
- *In the table* " **MAJOR EXPORTER AND IMPORTER COUNTRIES OF GRAPHITE IN RECENT YEARS** " *appearing on page* **30.5,** *Japan at 70-90(000t/y) should be listed under* IMPORTS *instead of* EXPORTS.

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General Review 1989

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THE CANADIAN ECONOMY IN 1989

Economic growth in Canada proceeded at a modest pace in 1989 as real output, measured by Gross Domestic Product, grew by 2.9%. This increase, although somewhat sluggish when compared with the buoyant 5.0% growth realized in 1988, was far from disappointing, given the strong Canadian dollar, stubborn inflationary pressures, continuing high interest rates and falling trade balances.

Strength in consumer spending and business investment in Canada in the earlier part of the year, combined with real economic growth of 3.0% in the United States, helped to offset the negative influences on the Canadian economy.

Real consumer spending on goods and services, after slowing in the first quarter of 1989 to an annualized rate of 1.5%, rebounded sharply to 5.4% in the second quarter, almost equalling the strong rates of growth achieved in the last half of 1988. Gains in disposable income stemming from the 1988 tax reform measures, combined with strong automobile purchases as a result of incentive programs, were believed to underlie this strong second-quarter performance. Third-quarter results were less encouraging. High interest rates caused consumers to save more and spend less and, as a result, personal expenditure on goods and services remained unchanged.

Business investment fared well in the first half of 1989. The mid-year "Survey of Private and Public Investment Intentions," published by Statistics Canada in July 1989, indicated that businesses expected to increase their capital and repair expenditures in 1989 relative to 1988 by 13.6%. Several factors accounted for this optimistic prediction. Corporate pre-tax profits in 1988 provided companies with funds required for re-investment purposes; the implementation of the Canada-U.S. Free Trade Agreement and the trend towards increased global competition pushed firms to invest in order to remain competitive; commodity prices remained strong throughout 1988 and the early part of 1989; and export earnings were healthy until adversely affected in 1989 by the run-up of the Canadian dollar. Following strong first- and second-quarter real increases in business investment in plant and equipment of about 3.5% and 2.8%, respectively, third-quarter results were less than satisfactory, suggesting that the investment intentions of mid-year were overly optimistic. Business plant- and equipment-spending in real terms rose only 0.7% in the third quarter, a significant weakening of growth after nearly three years of steady expansion. This third-quarter spending decline led analysts to believe that business investment could be losing momentum as a source of economic growth. Overall, the annual growth rate in 1989 for business investment in plants and equipment in real terms was expected to be about 10%, compared with 18.9% in 1988.

Poor third-quarter returns for industrial corporations were not expected to help a slowing investment climate. Operating profits for Canadian industrial corporations fell to $7.4 billion in the third quarter of 1989, the lowest level since the first quarter of 1987.

Conversely, residential construction was less affected by high interest rates in 1989 than some experts had expected, as the number of housing starts reached 215 382, down by only 3.2% from the number of starts recorded in 1988.

Also on a positive note, the unemployment rate dropped to 7.3% in September of 1989, the lowest level since 1981. The annual rate for 1989 averaged 7.5%, compared to 7.8% in 1988 and 8.8% in 1987. Lower unemployment levels encouraged labour to continue to press for wage increases that were higher than the rate of inflation.

Inflation, as measured by the Consumer Price Index (CPI) began to climb at the beginning of 1989, peaking in July on a year-to-year basis at 5.4%, the highest level since 1983. On an annual basis, the average increase in the CPI for 1989 was 5.0% compared with 4.1% in 1988.

Control of inflation remained the key policy concern of the Bank of Canada throughout 1989. In response to persistent inflationary pressure, the bank rate stayed high by historical standards, remaining within the 12.3-12.5% range throughout the second half of the year.

Attempts to control inflation were not without drawbacks. High domestic interest rates increased the costs of servicing the public debt and impacted negatively on the federal deficit. The federal government's fiscal position deteriorated in 1989 for the first time in four years as the deficit for fiscal year 1989-90 (on a Public Accounts basis) was projected to reach $30.5 billion.

Canadian short-term interest rates were three to four percentage points above rates in the United States for most of 1989 and close to five points higher by the end of the year. As a result, the Canadian dollar reached a 10-year high of US¢86.69 in December. On an annual basis, the dollar in 1989 averaged an estimated US¢84.46, the highest level in nine years.

The strong Canadian currency in combination with falling world commodity prices resulted in a worsening of Canada's current account balance. The current account, which includes exports, imports, services, investment income and transfers, posted a record deficit of $5.4 billion in the second quarter of 1989. Analysts projected a year-end current account deficit in the order of $20 billion, a significant rise from the $10.3 billion deficit recorded in 1988. Merchandise (goods only) trade, typically a source of strength to the Canadian economy, also moved into a quarterly deficit in 1989. After positive balances in the first and second quarters of $1.1 and $1.0 billion respectively, a deficit of $356 million was recorded in the third quarter of 1989, the first such instance since March of 1976. The cumulative merchandise trade surplus for 1989 was expected to reach about $4.5 billion, less than half the $10 billion surplus recorded in 1988.

The strength of Canada's economy is influenced to a considerable extent by the economic performance of the country's major trading partner, the United States. Nearly three quarters of Canada's merchandise exports are destined for the United States. In 1989 the U.S. economy experienced real growth of 3.0% compared with 4.4% in 1988. This softening of U.S. performance reduced the potential for an improvement in the Canadian export picture.

THE MINERAL INDUSTRY IN 1989

The Canadian mineral industry had another good year in 1989. While base-metal prices generally weakened as the year progressed, prices on average remained above those of 1988 ensuring acceptable profit margins for most of Canada's metal-mining industry. The second quarter pre-tax rate of return on capital employed was estimated to be in the 16% range, a level that for metal mines was comparable to 1988. The industry operated in 1989 at about 90% of capacity and was expected to reduce long-term debt from $7.8 billion in 1988 to $7.1 billion in 1989. Investment levels in 1989 were less robust than in 1988 when the industry had invested some $2.5 billion in new plants and equipment. Revised investment intentions for 1989 placed the expected value about 3% below the 1988 amount.

While the impact of the high Canadian dollar on Canada's export trade was generally negative, the effect on the mineral industry was proportionally less severe as strong global business investment continued to underpin demand for base metals. Should mineral prices continue to weaken, a strong Canadian dollar will become a more serious concern for the industry.

The value of Canadian mineral production, including metallic minerals, nonmetallic minerals, structural materials and fuels, totalled $39.1 billion in 1989 compared with $37.0 billion in 1988, an increase of nearly 6%.

The Canadian Mineral Industry Value of Production 1988 and 1989

	1988	1989	Change
	($million)		(%)
Metals	13 607.9	14 329.0	5.3
Nonmetals	2 717.2	2 540.9	-6.5
Structurals	2 863.2	2 890.8	1.0
Total nonfuels	19 188.3	19 760.6	3.0
Fuels	17 772.9	19 361.2	8.9
Total	36 961.2	39 121.8	5.8

Note: Totals may not add due to rounding.

The metallic minerals sector performed well in 1989, with value of output reaching $14.3 billion, up 5.3% over the $13.6 billion reported in 1988. On the other hand, the value of production of nonmetallics declined from $2.7 billion in 1988 to $2.5 billion in 1989, a decrease of 6.5%. The value of output for structural materials remained unchanged at $2.9 billion from the value recorded in 1988. As a whole, the nonfuel mineral sector accounted for $19.8 billion, or 51% of the overall value of mineral output.

The fuels sector, which includes crude petroleum, natural gas, natural gas by-products and coal, accounted for nearly $19.4 billion of the overall value of output in 1989, an increase of about 9% relative to the previous year. While the volume of petroleum output decreased slightly, the value of output increased by about 16%. Stronger prices in 1989 relative to 1988 accounted for this positive result.

The top ten commodities in terms of value of output in 1989 were: petroleum ($10.7 billion), natural gas ($5.2 billion), nickel ($3.1 billion), zinc ($2.8 billion), copper ($2.4 billion), gold ($2.3 billion), coal ($1.8 billion), natural gas by-products ($1.6 billion), iron ore ($1.5 billion), and uranium ($1.0 billion).

When fuels are included, Alberta's contribution to total mineral output represented the largest share at $16.2 billion or 41.4% followed by Ontario with output valued at $7.3 billion or 18.7% of the total. British Columbia accounted for $4.1 billion, Saskatchewan for $3.0 billion, Quebec for $2.8 billion and Manitoba for $1.7 billion. The remaining provinces accounted for the balance of $4.0 billion, roughly 10% of the total.

The employment level for all of the mineral industry changed little from the previous year, with the total number of workers down slightly from 392 000 in 1988 to 390 000 in 1989. Employment in metal mines, nonmetal mines, structural materials and coal mines was estimated to be 75 500 in 1989, about 2% below the 1988 level. Employment in smelting and refining and in the crude steel industries remained virtually unchanged at 75 000, while mineral manufacturing employment declined slightly from 240 000 in 1988 to 237 000 in 1989.

Exploration expenditures directed to the discovery of new supplies of minerals were expected to reach about $900 million in 1989, down from the record $1.4 billion recorded in 1988 and $1.3 billion in 1987. The Canadian Exploration Incentive Program (CEIP), a two-year program, came into effect in January 1989. For approved projects and up until February 1991, CEIP will pay 30% of eligible expenses up to a maximum of $10 million. A number of provincial government programs that were in effect during 1989 were also intended to stimulate investment in mineral exploration.

Exports of Canadian minerals continued to make an important contribution to Canada's merchandise trade surplus. Total value of exports of crude minerals, smelted and refined products, and semi-fabricated and fabricated forms (excluding fuels but including coal) for the first nine months of 1989 was estimated at $19.1 billion. Crude minerals alone accounted for about $7.1 billion. When mineral fuels are included, the United States accounted for about 66% of the total value of Canada's mineral exports in the first nine months of 1989. Over the same time period and on an international basis, minerals (including fuels) made up about one quarter of the value of all of Canada's exports. Imports of these mineral products (excluding fuels but including coal) for the first nine months of 1989 were estimated to be about $11.0 billion.

Despite declining prices, nickel continued to be the major performer among the metals in 1989 with value of output at $3.1 billion in 1989 compared to $2.8 billion in 1988, an increase of more than 10%. Volume of output was slightly down from planned levels as a result of technical problems at one of the mines. Toward the end of the year, there were some signs that producers' inventories were starting to build and that demand for nickel from the stainless steel sector was slowing. Stainless steel accounts for approximately 60% of nickel demand. Nickel prices on the London Metal Exchange (LME) declined over the course of the year from a monthly average of US$8.06/lb. in January to US$4.00/lb. in December. These prices, although well below the US$10.84/lb. experienced in March of 1988, were still high compared to average prices during the 1980s.

Exploration activity remained focused on gold in 1989. Gold production reached 158 t, up by nearly 18% from the 135 t recorded in 1988. On the other hand, value of output at $2.3 billion remained virtually unchanged from the previous year, reflecting a 12.8% drop in the price of gold from an average US$437.11/oz. in 1988 to US$381.27/oz. in 1989.

As a result of the closing of primary silver mines in Northern Ontario and the Yukon, Canada's output of silver in 1989 was 1262 t, a 12.5% drop from 1443 t in 1988. Value of output also declined from $386 million in 1988 to $263 million in 1989. The price of silver, which had averaged about US$6.51/oz. in 1988, dropped in 1989 to an average of US$5.50/oz. All domestic production of silver will now be by-product silver from base-metal or gold-mining operations.

Strikes coupled with some technical problems reduced Canadian copper output for the second consecutive year. Mine production fell to 706 117 t in 1989 from 758 478 t in 1988 and a record 794 149 t in 1987. On the other hand, stronger prices enabled the value of output to rise. The average LME price of high-grade copper in 1989 was US$1.29/lb. compared with US$1.18/lb. in 1988.

Lead production was also adversely affected by technical difficulties at several mines. The volume of lead output fell from 351 148 t in 1988 to 275 800 t in 1989. Lead prices had weakened during the first half of 1989 but picked up as battery manufacturers prepared for the high-demand winter period. The average price of lead on the LME in 1989 was US¢30.6/lb., up marginally from the US¢29.7/lb. recorded in 1988. The production of lead was expected to recover in 1990 owing to expansion projects and new mines coming on-stream, but with the announced closure of Canada's historic Sullivan mine in early 1990, it is more likely that lead production in 1990 will drop below the 1989 level.

Canada continued to be the world's largest producer of zinc concentrates in 1989, even though volume of output was down by 4%. (As with lead, the closure of the Sullivan mine in 1990 will cause a further drop in Canada's production of zinc concentrates.) The value of output, on the other hand, climbed by more than 25% from $2.3 billion in 1988 to $2.8 billion in 1989. The SHG (special high-grade) price of zinc peaked on the LME in March 1989 at nearly US$0.97/lb. but stabilized at around US$0.68/lb. by the end of the year. Even though zinc prices have almost doubled over the past two years, zinc-coated steel in galvanized applications remains the most cost-effective method of protecting steel. Zinc prices are expected to be lower in 1990 as a result of a slowing economy and reduced automobile sales.

Canada's iron ore production reached 40.8 Mt in 1989, a 2% increase over the 1988 level. A tightening of the market for iron ore (especially in pellets) in 1988 continued into 1989, resulting in a price increase of 13% to 18% for deliveries to Europe and Japan. As a result, the value of output increased to $1.5 billion in 1989, up 13% from the $1.3 billion recorded in 1988. After significant increases in steel production and consumption in 1988, sales levelled out in 1989 and are not expected to change in 1990.

The volume of asbestos production declined in 1989 to 691 408 t, down from 710 358 t in 1988. The value of production increased slightly from $251 million in 1988 to nearly $260 million in 1989. The regulatory framework associated with this commodity continued to have an adverse impact on some world markets for asbestos products.

Canada produces slightly more than one quarter of the world's potash and is by far the leading exporter. Production in 1989 was about 7.0 Mt, down from 8.2 Mt in 1988. Prices remained relatively stable in 1989 as a result of producers maintaining their operations at about 70% capacity levels.

The year 1989 proved to be another record year for the Canadian coal industry as the 71 Mt produced surpassed the previous year's record of 70.6 Mt. On average, prices remained relatively stable and value of output changed very little relative to the previous year. Domestic demand for thermal coal is expected to continue growing slowly as new power stations are built in Alberta, Saskatchewan, New Brunswick and Nova Scotia.

OUTLOOK 1990

Canada's economy in 1990 is expected to see the slowest growth in a decade. An easing in spending by consumers, businesses and government, the possibility of continuing high interest rates, problems with Canada's trade performance and a slowing U.S. economy are expected to impact negatively on Canada's economic performance. Forecasts of real growth in Canada's Gross Domestic Product (GDP) are clustered in the 1.25-1.75% range for 1990, down from 2.9% in 1989 and 5.0% in 1988. A mild recession in 1990 seems to be a distinct possibility. Recession may be defined as a drop in real GDP for two successive quarters.

The rate of inflation, as measured by the Consumer Price Index, is expected to moderate in 1990 to a level below the annual average of 5.0% reported in 1989. Consumer spending, forecast to grow in 1990 by little more than 1.7% in real terms, will be one of the factors helping to alleviate inflationary pressures. An anticipated weakness in business investment, predicted in 1990 as a result of declining profits, rising labour costs and the expectation that interest rates might remain high, will further exacerbate the effects of weak consumer spending.

As signs of economic slowing become more evident, the Bank of Canada is expected to move away from the position of fiscal restraint maintained throughout 1989; as a result, short-term interest rates could decline to about 10% or 11% in 1990. If this were to happen, the Canadian dollar would probably drop to about US¢83.

The strength of Canada's economy is heavily intertwined with that of the United States. As a result, any softening of U.S. economic performance is expected to exert a negative influence on the Canadian economy. Analysts expect real gross national product growth of about 2% in the United States in 1990.

What are the prospects for mining and minerals as the 1990s begin? Mining faces the new decade from a position of relative strength. Solid achievements in restructuring have led the industry back into profitability, and Canadian companies are well positioned to manage a period of weaker prices. As a result, most analysts feel cautiously optimistic about the prospects for the base-metals industry in Canada in the 1990s. On the demand side, analysts believe that replacement of the world's infrastructure, stimulated by increased global competition, will provide a substantial cushion for future base-metals demand. In addition, surprisingly strong growth in the Japanese and European economies could provide a continued source of mineral and metal demand. On the domestic front, the Canada-U.S. Free Trade Agreement should enhance the consumption of metals for both countries.

While the outlook for the mineral industry in 1990 is generally positive, there are difficulties ahead. Analysts are expecting net profits of base-metal companies to drop in 1990 relative to 1989, principally as a result of lower base-metal prices combined with slower economic growth in North America. A drop in mineral prices to the level of the early 1980s is not anticipated, partly because the industry is expected to exercise caution before bringing new capacity on-stream.

Declining intensity-of-use and substitution continue to be of concern to the industry. A rise in the use of metal-displacing substitutes such as plastics, ceramics and composites will impact negatively on metal demand. There is a continuing need for development of metal-based materials and products in order to offset increases in the use of these substitutes. One area of market potential for the industry could lie in the field of materials engineering. New products incorporating "advanced materials," which include the specialty metals such as beryllium, gallium and germanium, are expected to become important components of the mineral product lines.

As the decline in Canada's base-metals reserves continues, neglect of base-metal exploration remains a concern. If Canada is to find enough mineral deposits to reolace those nearing exhaustion while at the same time keep up with growth in world demand, an immediate increase in base-metal exploration is necessary.

The mineral industry faces other crucial issues as the new decade approaches. Increasingly tough global competition, in particular from the Third World, and the trend to trade liberalization will remain high on the list of concerns.

In addition to the technical and competitive pressures with which the industry continues to cope, there is, at the same time, growing preoccupation with environmental protection and worker health and safety. As a result, all industrial sectors will be required to meet increasingly stringent regulations in the 1990s. The Mining Association of Canada has taken a proactive stance in this regard. The Board and membership of the Association, having approved an Environmental Policy in 1989, will work in 1990 to develop detailed guidelines for environmental practices.

Overall, the prospects for the Canadian mineral industry in 1990 appear reasonably bright. Canadian companies have positioned themselves well to manage a period of weaker prices. Through rationalization, restructuring, improved technology and skilful management, firms have generally reduced debt, cut costs and improved productivity. As a result, Canada's mineral industry is well positioned to manage the problems and opportunities of the next decade and should maintain its position as a significant contributor to the economy of Canada.

Note: Information contained in this review was current as of mid-January 1990.

CANADA, PRODUCTION OF LEADING MINERALS, 1988 AND 1989

	1988	1989p	Percent change 1989 1988	1988	1989p	Percent change 1989 1988
	(000 tonnes except where noted)			($ millions)		
Metals						
Nickel	198.7	196.1	-1.3	2 790.4	3 079.9	10.4
Zinc	1 370.0	1 315.3	-4.0	2 264.6	2 843.6	25.6
Copper	758.5	706.1	-6.9	2 393.6	2 414.6	0.9
Gold (kg)	134 812.6	158 439.7	17.5	2 332.0	2 297.7	-1.5
Iron ore	39 933.9	40 773.1	2.1	1 323.2	1 492.9	12.8
Uranium (tU)	12 065.8	11 563.6	-4.2	1 018.7	989.7	-2.8
Lead	351.1	275.8	-21.5	356.1	287.4	-19.3
Silver (t)	1 443.2	1 262.2	-12.5	386.3	263.3	-31.8
Platinum group (kg)	12 541.2	10 375.2	-17.3	190.9	143.9	-24.7
Molybdenum (t)	13 535.2	13 716.1	1.3	121.1	122.4	1.0
Nonmetals						
Potash (K_2O)	8 154.4	7 035.5	-13.7	1 167.7	947.0	-18.9
Sulphur, elemental	5 981.5	5 183.4	-13.3	444.0	440.7	-0.7
Salt	10 687.2	11 349.8	6.2	246.7	270.2	9.5
Asbestos	710.4	691.4	-2.7	251.1	258.7	3.0
Sulphur in smelter gas	856.5	831.2	-2.9	85.2	83.0	-2.5
Gypsum	9 511.6	8 456.8	-11.1	92.5	81.5	-11.9
Structurals						
Cement	12 349.9	12 550.4	1.6	971.3	998.2	2.8
Sand and gravel	289 763.2	277 122.4	-4.4	861.2	837.8	-2.7
Stone	122 029.9	116 656.7	-4.4	642.3	632.6	-1.5
Clay products	. .	. .	. .	196.7	215.0	9.3
Lime	2 518.0	2 616.5	3.9	191.7	207.2	8.1
Fuels						
Petroleum (000 m^3)	93 806.0	90 427.0	-3.6	9 167.9	10 668.5	16.4
Natural gas (million m^3)	90 911.0	92 837.0	2.1	5 207.1	5 222.0	0.3
Coal	70 644.0	71 000.0	0.5	1 804.3	1 835.5	1.7
Natural gas by-products (000 m^3)	22 556.0	23 144.0	2.6	1 593.6	1 635.1	2.6

p Preliminary; . . Not applicable.
Note: Figures have been rounded.

CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1989 (9 MONTHS)

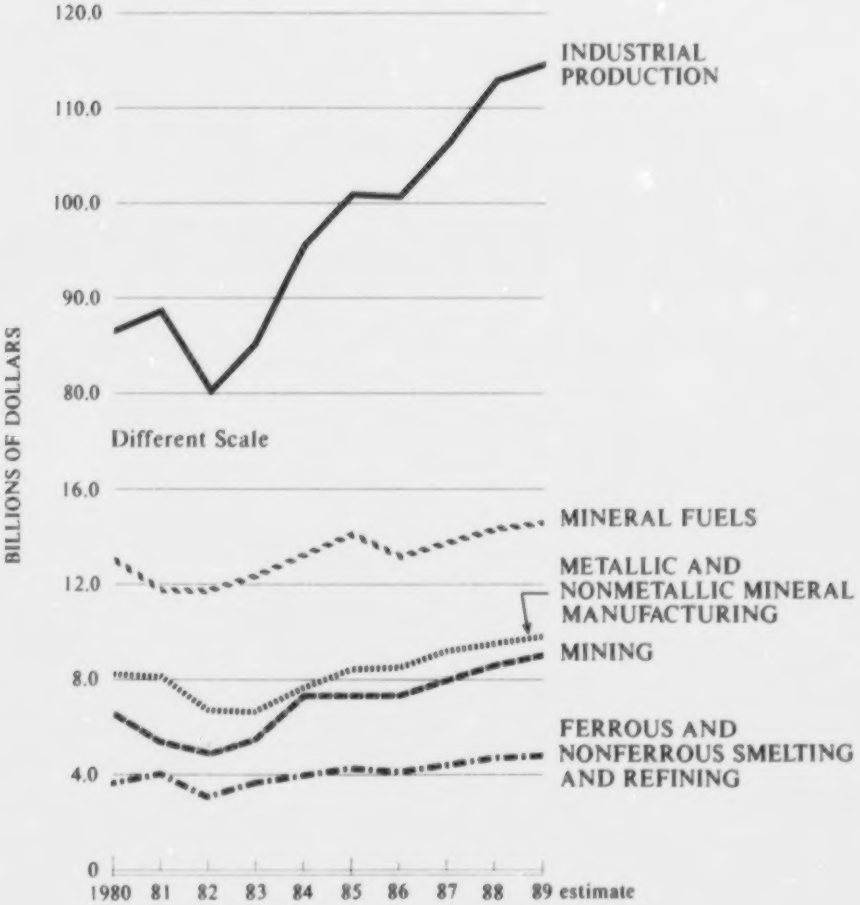
Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone plastering material, lime and cement	303 887	128 341	64 919	530 864	1 028 011
26	Ores, slag and ash	412 093	992 329	788 020	390 911	2 583 353
27	Mineral fuels, oils and products of their distillation, etc.[2]	7 775 307	119 511	1 145 022	496 028	9 535 868
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	1 009 126	112 201	35 346	43 997	1 200 670
31	Fertilizers	605 545	51 804	57 236	405 580	1 120 165
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	207 163	5 989	1 853	9 462	224 467
69	Ceramic products	36 594	799	296	6 906	44 595
70	Glass and glassware	251 463	19 295	3 192	17 483	291 433
71	Natural/cultured pearls, precious stones and metals, coins, etc.	918 865	132 882	258 638	700 425	2 010 810
72	Iron and steel	1 269 469	133 534	12 141	350 882	1 766 026
73	Articles of iron or steel	1 179 641	30 619	3 917	120 538	1 334 715
74	Copper and articles thereof	665 107	380 665	4 856	91 096	1 141 724
75	Nickel and articles thereof	128 983	145 393	11 067	339 187	624 630
76	Aluminum and articles thereof	2 226 358	174 927	266 387	307 916	2 975 588
78	Lead and articles thereof	32 715	29 532	3 773	28 773	94 793
79	Zinc and articles thereof	666 998	38 043	31 673	86 717	823 431
80	Tin and articles thereof	6 440	90	48	484	7 062
81	Other base metals; cermets; and articles thereof	35 230	13 719	6 834	22 827	78 610
	Total	17 730 984	2 509 673	2 695 218	3 950 076	26 885 951

Source: Statistics Canada,Catalogue 65–003 (Quarterly).

[1] Harmonized System Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System," as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Value of coal exports included in Chapter 27 is $1717 million.

Figure 1

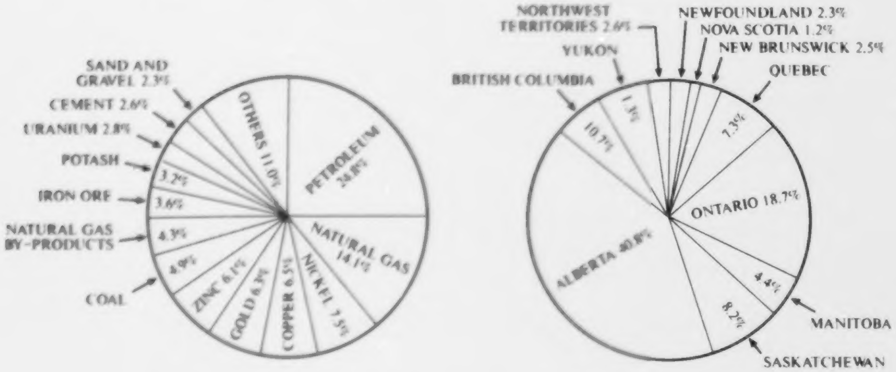
GROSS DOMESTIC PRODUCT AT 1981 PRICES



Source: Statistics Canada

Figure 2

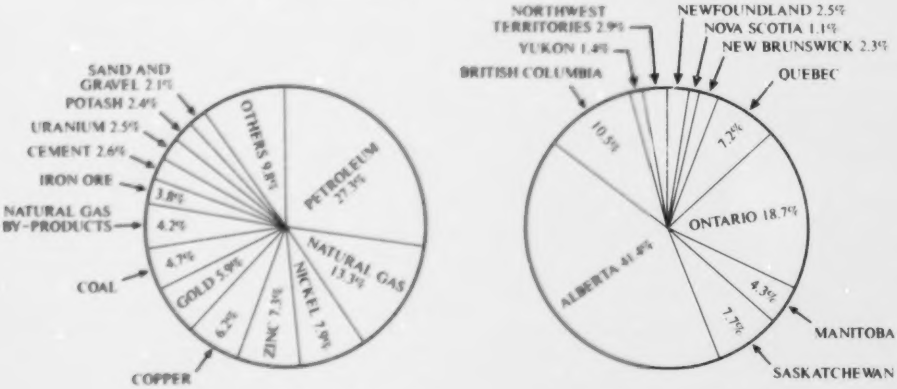
CANADA, VALUE OF MINERAL PRODUCTION, 1988



% OF TOTAL BY COMMODITY

% OF TOTAL BY PROVINCE

CANADA, VALUE OF MINERAL PRODUCTION, 1989



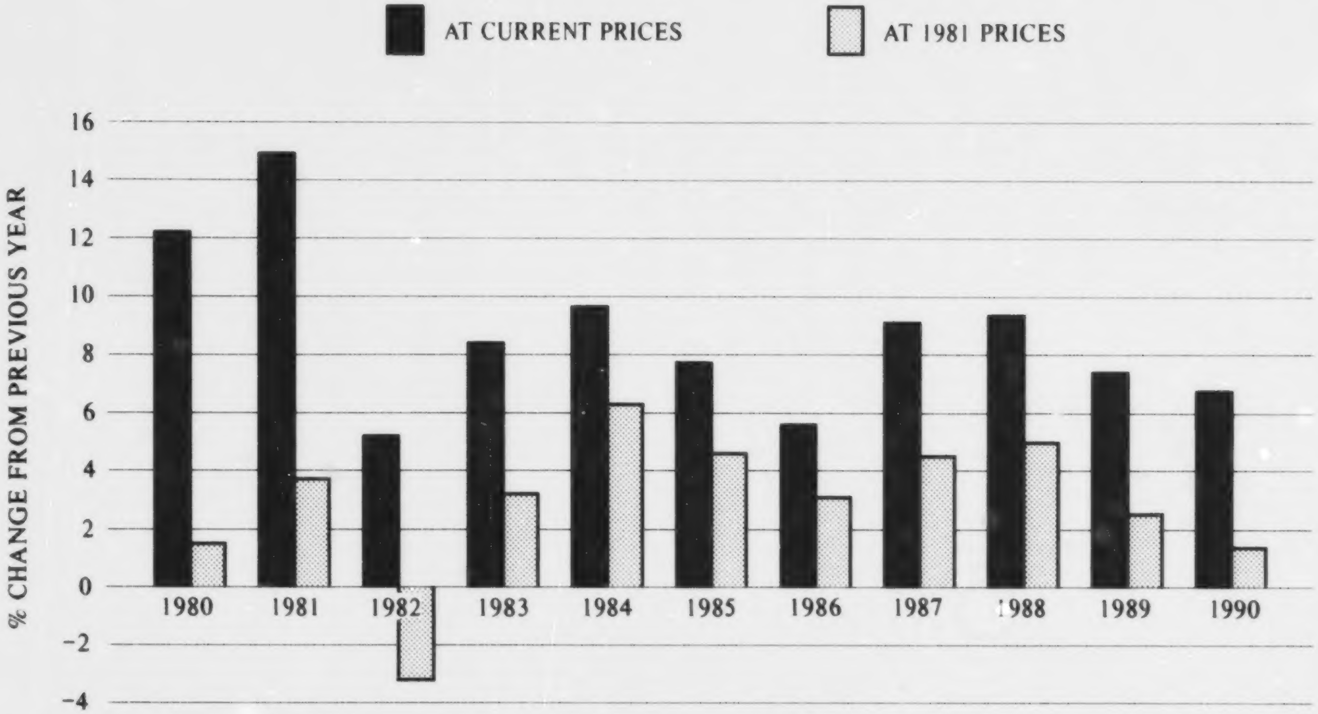
% OF TOTAL BY COMMODITY

% OF TOTAL BY PROVINCE

Figure 3

TRENDS IN CANADIAN ECONOMIC ACTIVITY

(% CHANGE IN GROSS DOMESTIC PRODUCT)

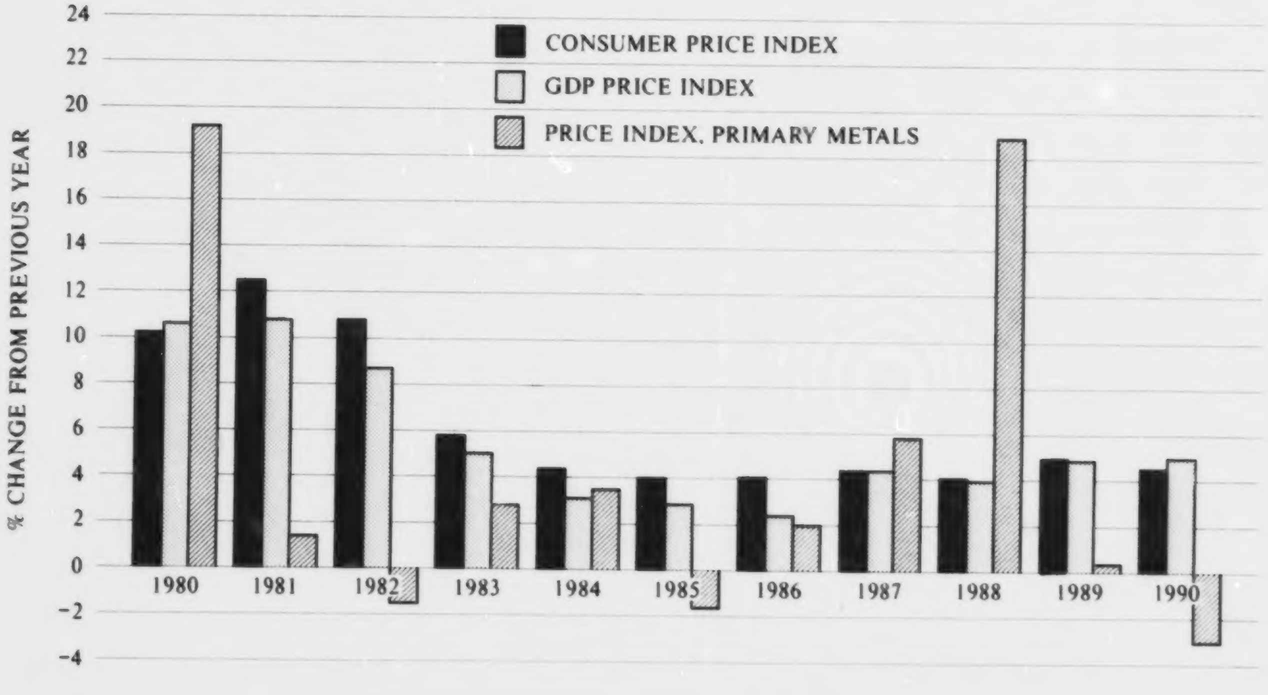


Source: Statistics Canada.

NOTE: FIGURES FOR 1989 AND 1990 ARE ESTIMATED.

Figure 4

CANADIAN PRICE TRENDS



Source: Statistics Canada.

NOTE: FIGURES FOR 1989 AND 1990 ARE ESTIMATED.

International Scene

1989

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The past year marked some dramatic changes on the world political scene and set the stage for equally dramatic changes in the expanding global market. Democratic forces have swept much of Eastern Europe and have been strengthened in Latin America. These forces, combined with more traditional trade liberalization movements and corporate reorganizations, augur well for a rapid expansion and change in the global market during the 1990s.

For Canada's mineral industry, the world economic and trade scene in 1989 brought mixed blessings. World demand for minerals was brisk throughout the first half of the year and prices remained buoyant but a rising Canadian dollar dampened export potential and profit margins. The coming into force of the Canada-U.S. Free Trade Agreement (FTA) marked a very important trade policy event but its overall impact won't be fully evident for another few years. In the EC, further progress was made in what has become known as "Europe 1992", a broad exercise to complete the internal market for the free movement of goods, capital, services and people within the Community's twelve Member States. In the Pacific Basin, economic development has been maintained at a high level and one can detect some evidence of economic regionalism.

MINERAL TRADE

Preliminary statistics indicate that Canada's mineral and metal exports, broadly defined and including $7.8 billion worth of petroleum and natural gas, were valued at $26.9 billion for the first nine months of 1989. Imports for the same period were $15.0 billion. The level of both exports and imports were up marginally from 1988. The United States accounted for two thirds of these exports and 54% of Canada's imports. Japan remained the second largest market, accounting for 10% of exports and the EC 9.3%.

Apart from energy products, the main commodity exports were as follows: crude materials -- iron ore to the United States; copper concentrates to Japan; iron ore and zinc concentrates to the EC; sulphur and potash to the United States and a host of other countries; smelted and refined metals -- aluminum, copper, iron and steel, gold, nickel, silver and zinc to the United States; aluminum and gold to Japan; and copper and nickel to Europe. Canada's coal exports, valued at $1.7 billion for the first nine months of 1989, went mainly to Japan.

BILATERAL MATTERS

The implementation on January 1, 1989 of the FTA marked the first step in eliminating barriers to trade in goods and services between Canada and the United States. Tariffs on some products were fully eliminated whereas on most goods the first cut in a five- or ten-year phase-out was made. Other FTA implementation activities during the year included: (i) two meetings of the newly established Canada-U.S. Trade Commission (headed by Canada's Minister for International Trade and the U.S. Special Trade Representative); (ii) the creation and meeting of several dispute settlement and special panels; (iii) an agreement to accelerate the phase-out of tariffs on some 400 items, the target date being April 1, 1990; (iv) the creation and first technical meeting of the Subsidies and Trade Remedies Working Group whose task is to negotiate, over a five- or seven-year period, new bilateral regimes for subsidies/countervail, and for anti-dumping. For most minerals and metals, bilateral tariffs will be fully eliminated by 1993 except for a few commodities such as lead, magnesium, zinc, a few copper and molybdenum products, and iron and steel for which U.S. producers have traditionally exerted protectionist pressures. The U.S. Nonferrous Metals Producers Committee continued its protectionist attitudes and succeeded in having copper and lead identified under Section 409 b) of the U.S.'s FTA implementation act. Although this identification did not trigger any specific trade actions, in recognizing the petition, the U.S. Trade Representative accepted the U.S. copper and lead industries view that they could face increased competition from alleged subsidized Canadian imports and a deterioration of their competitive positions.

The Commission of the European Communities continued its drive to complete the internal market as envisaged in the 'EC Single Act' of 1987. In legislative terms, this means the preparation and enactment of close to 400 Directives by 1992 aimed at making the EC a truly common market. Although 'Europe 1992' is an ambitious program that carries important implications for Europeans and for persons and firms dealing with Europeans, it is not expected to significantly alter trade and investment patterns for minerals and metals. It should, however, prompt overall positive impacts as economic growth is revitalized and the EC market becomes more globally competitive.

The Asia-Pacific region continued its rapid development as a leading trade and economic force. Japan and the so-called 'four tigers' (Taiwan, South Korea, Singapore and Hong Kong) enjoyed strong economic growth combined with trade expansion, whereas relations with the People's Republic of China took an abrupt turn following the June 6th events in Tienanmen Square. Despite some setbacks, which included the People's Republic of China's hasty application to re-join the GATT, the nation's leaders re-affirmed a high priority to developing that country's nonferrous metals sector. One manifestation of this priority was the official opening in September 1989 of a Toronto office called Nonferrous Metals Industries (Canada) Inc.; it is a subsidiary of the trading arm of China National Nonferrous Metal Industry Corporation (CNNC). Bilateral activities in this sector are handled by a Canada/China Non-Ferrous Working Group established in 1988. The Chinese have identified a number of business opportunities for Canadian private sector participation.

The significant role of the U.S.S.R. in the production and consumption of minerals and metals, and its potential as a market and as a supply competitor, command increasing attention. Canadian imports of Soviet minerals and metals totalled $115 million in 1988 (including $109 million of platinum), and could exceed $100 million in 1989. These figures reflect only products that enter Canada directly from the U.S.S.R. They do not show imports through third countries or Soviet material being supplied to offshore facilities owned by Canadian companies: these amounts are understood to be considerable. Contacts with Soviet officials and with Soviet production entities are expected to increase significantly as long as the reform movement continues. It has been formally agreed, for example, that there will be a second bilateral exchange of nickel missions in 1990. Other visits and business ventures are in various planning and negotiation stages.

MULTILATERAL MATTERS

Although the FTA grabbed most of the public trade policy discussion over the past two years, the Uruguay Round of multilateral trade negotiations (MTN) launched in September 1986 is also very important to Canada. Canada hosted a mid-term ministerial review meeting in December 1988 at which time the 96 GATT contracting parties participating in the MTN confirmed their desire to complete negotiations by the end of 1990. The Uruguay Round is novel in that negotiators are going beyond the traditional goods sector to develop rules for trade in services and trade-related intellectual property. They are also attempting to re-write rules for tighter disciplines on trade distorting subsidies and the application of countervailing duties. The latter will be especially important for Canada as those rules will apply for Canada's bilateral trade with the United States until a new regime is negotiated under the FTA. With regard to tariffs, negotiators contemplate an outcome similar to the Tokyo Round of MTN with the first cuts to be made in 1991. As of the end of 1989, negotiators had still not agreed whether to apply a formula cut or to proceed with a line-by-line approach.

On December 22, 1989, the International Tin Council (ITC) announced that it had passed a regulation accepting the creditors offer of an out-of-court settlement of debts arising from the suspension of the ITC's buffer stock activities. This Canadian initiative, launched in mid-1988, will bring to an end all the litigation between creditors, the ITC and its members. Payment of UK£182.5 million is scheduled for the end of the first quarter in 1990.

The Convention on the Law of the Sea drawn up in 1982 assumed a higher profile than in recent years. The number of countries (none of them industrialized) which have ratified the Convention has increased to 42 of the 60 necessary to bring the Convention into force. Thus time for the resolution of any outstanding problems is finite. Changes after the entry into force of the Convention, i.e. through amendments of the Convention, will be extremely difficult.

The industrialized countries, including Canada, have serious problems with several elements of the Convention dealing with deep sea-bed mining. The United States, which did not sign the Convention and is not present for negotiations in the Preparatory Commission for the International Sea-Bed Authority, also has serious reservations about this part of the Convention. The Bush Administration has been under pressure to review its 1982 decision to absent the United States from ongoing negotiations. No early resolution is expected and representations to American authorities will probably continue in 1990. The reality of mining the deep sea-bed for its polymetallic nodules seems as economically remote as ever. Only the most enthusiastic proponents are suggesting that nickel, copper and cobalt will be mined in appreciable amounts before 2010.

The question of the ratification of the LOS Convention has emerged as a public issue in the context of the environment. There is pressure from environmental groups for its ratification for the presumed increase in legal controls it will bring to pollution and fisheries issues. It will only be in 1990, however, that the first look will be taken at the environmental rules and regulations to govern deep sea-bed mining.

Environmental concerns pervaded other international fora. The Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal was negotiated by 116 countries, including Canada, in the spring of 1989. The Convention will come into force once 20 countries have ratified; this is expected to happen in 1990.

The Basel Convention, depending upon how it is applied and the extent to which it is ratified, inter alia, would place significant restrictions on the movement of secondary materials. Because the metals industry is an international industry that recycles extensively, this Convention poses important challenges and possible opportunities to the metals industry. The Convention defines recycling as "disposal": scrap recycling thus appears to be classified as waste disposal. Export controls, reduction of transboundary flows and other restrictions are therefore probable for copper and zinc compounds and asbestos as well as the metals and compounds of beryllium, zinc, arsenic, selenium, cadmium, antimony, tellurium, mercury, thallium, and lead. Although the Convention provides for consideration of a complete or partial ban on transboundary movements of hazardous wastes or other wastes, it also provides for pragmatic approaches to transboundary movements. For example, it provides for bilateral or regional agreements on the movement of hazardous and other wastes as long as there is no derogation from environmentally sound management practices. Furthermore, Contracting Parties will be able to export wastes if they do not have the technical capacity to handle the wastes or if the wastes were to be recycled in the importing state.

Elsewhere on the environmental front, the World Bank which in 1969 established an Office of Environmental Affairs, has increasingly devoted more attention to this issue. The Bank had been criticized for paying insufficient attention to environmental matters, particularly in a number of lending operations such as the Polonoroeste project in Brazil, the Botswana Lifestock project, and the Indonesia Transmigration project. Thus, in 1987 the Bank sharply adjusted its policies to favour environmental management. The Bank increased the resources devoted to the environment to 100 staff years and environmental issues are now fully integrated in its approach to development. At a conference in Tokyo in September 1989, Barber B. Conable, President of the World Bank, remarked: "I expect that in the next three years Bank support for free-standing environmental projects will be near US$1.3 billion. Even that may not be as important as our efforts to increasingly integrate environmental values into our on-going development program."[1]

Perhaps the most ambitious undertaking for environmental protection emerged from a United Nations General Assembly decision late in 1989 for the 159-member body to draft a treaty on protecting the atmosphere and encouraging ecologically sound development. A world conference is to be convened in 1992 in Brazil on this matter and it is envisaged that a treaty may be adopted.

The High Level Group on Commodities within the Organization for Economic Cooperation and Development continued its research on commodity policy, especially as it relates to minerals and metals. The High Level Group meets regularly at a government officials level and relies heavily upon advice provided by the Raw Materials Sub-Committee of the Business and Industry Advisory Council (BIAC), chaired by a Canadian. In 1989, the High Level Group directed the OECD Secretariat to begin a study of government support practices in the exploration for, and the mining, processing and initial fabrication of six nonferrous metals. The role and treatment of environmental regulations will form part of the study. The study will take several years to complete.

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[1] Conable, Barber, B.; "Development and the Environment, A Global Balance" in Finance and Development, Vol. 26, No. 4, December 1989, p. 4.

A PERSPECTIVE FOR THE 1990s

The decade of the 1990s poses some real political, economic and social challenges for the world. Our approach to these challenges will have important implications for the global market and the world mineral industry. The challenges can be summarized as follows:

- a need to maintain a balance between environmental protection and sustainable economic development,
- a revitalization of the global trading system through the Uruguay Round -- i.e., the establishment of a common ground for furthering trade liberalization through the GATT,
- full implementation of the Canada-U.S. Free Trade Agreement,
- the economic repercussions of the economic integration and structural adjustment incident on the emergence of Europe 1992,
- the economic restructuring of the U.S.S.R. and Eastern Europe,
- the nascent development of some semblance of economic regionalism of the Pacific Basin, and
- technological developments in mining, metallurgy, advanced materials, and environmental protection.

Although all these challenges contain elements of uncertainty, the economic restructuring of the U.S.S.R. and the rest of Eastern Europe poses some real dilemmas for the western world mineral industry. It is widely held that on a per capita basis, the intensity of mineral and metal use is considerably higher in the U.S.S.R. than in the western economies. The dilemma is: will a high level of intensity be maintained and require imports of raw materials or, will the level diminish and divert domestic supplies into world export markets? Governments will have to work closely with industry officials in monitoring and documenting current practices and changing trends.

Note: Information contained in this review was current as of mid-January 1990.

CANADA, VALUE OF IMPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1989 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone plastering material, lime and cement	258 196	13 987	943	69 626	342 752
26	Ores, slag and ash	283 346	90 990	0	174 249	548 585
27	Mineral fuels, oils and products[2] of their distillation etc.	1 375 110	1 287 253	593	1 865 336	4 528 292
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	612 427	78 903	26 436	350 759	1 068 525
31	Fertilizers	125 385	8 528	451	3 563	137 927
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	170 248	76 681	2 790	17 842	267 561
69	Ceramic products	156 443	167 227	48 010	82 877	454 557
70	Glass and glassware	552 702	72 734	24 798	61 439	711 673
71	Natural/cultured pearls, precious stones and metals, coins, etc.	623 390	145 107	6 483	357 276	1 132 256
72	Iron and steel	825 724	332 134	76 471	413 584	1 647 913
73	Articles of iron or steel	1 320 008	227 727	127 326	277 570	1 952 631
74	Copper and articles thereof	369 663	34 135	8 040	107 330	519 168
75	Nickel and articles thereof	65 577	9 940	62	57 593	133 172
76	Aluminum and articles thereof	1 166 017	92 442	4 583	65 855	1 328 897
78	Lead and articles thereof	17 373	643	31	3 417	21 464
79	Zinc and articles thereof	17 242	1 014	129	4 935	23 320
80	Tin and articles thereof	12 607	2 034	247	28 964	43 852
81	Other base metals; cermets; and articles thereof	93 542	10 163	3 003	20 219	126 927
	Total	8 045 000	2 651 642	330 396	3 962 434	14 989 472

Source: Statistics Canada,Catalogue 65-003 (Quarterly).

[1] Harmonized System Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Value of coal imports included in Chapter 27 is $561 million.

CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1989 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt; sulphur; earths and stone plastering material, lime and cement	303 887	128 341	64 919	530 864	1 028 011
26	Ores, slag and ash	412 093	992 329	788 020	390 911	2 583 353
27	Mineral fuels, oils and products[2] of their distillation etc.	7 775 307	119 511	1 145 022	496 028	9 535 868
28	Inorganic chemicals; compounds of precious metals, radioactive elements, etc.	1 009 126	112 201	35 346	43 997	1 200 670
31	Fertilizers	605 545	51 804	57 236	405 580	1 120 165
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	207 163	5 989	1 853	9 462	224 467
69	Ceramic products	36 594	799	296	6 906	44 595
70	Glass and glassware	251 463	19 295	3 192	17 483	291 433
71	Natural/cultured pearls, precious stones and metals, coins, etc.	918 865	132 882	258 638	700 425	2 010 810
72	Iron and steel	1 269 469	133 534	12 141	350 882	1 766 026
73	Articles of iron or steel	1 179 641	30 619	3 917	120 538	1 334 715
74	Copper and articles thereof	665 107	380 665	4 856	91 096	1 141 724
75	Nickel and articles thereof	128 983	145 393	11 067	339 187	624 630
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Regional Outlook 1989

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The preliminary estimate of the value of production of metals, nonmetals, structural materials and coal in 1989 is $21.6 billion, an increase of $603 million, or 2.9%, over 1988. The metals sector showed an increase of 5.3%, structural materials increased by 1.0%, coal increased by 1.7% and nonmetals decreased by 6.5%. When natural gas, natural gas by-products and crude petroleum are included, the value of production was $39.1 billion, an increase of 5.8% over 1988.

The mineral industry has long been a major contributor to the regional economies of Canada. This is recognized in the Minerals and Metals Policy of the Government of Canada where it is stated that "The Government of Canada is committed to fostering the development of the minerals and metals sector as a foundation for regional economic development."

One acknowledgement of this commitment was the decision of the federal government to fund joint federal-provincial agreements called Mineral Development Agreements (MDAs), aimed at strengthening and diversifying the mineral sector of the provincial economies. Through these agreements, aid is made available to the industry, often in the form of geological maps, reports and studies, to assist in the discovery and development of mineral resources. The agreements allow both levels of government to coordinate their activities and focus on the specific needs of the individual regions.

The past year saw the termination of MDAs with Newfoundland, Nova Scotia, New Brunswick, Manitoba, Saskatchewan, Prince Edward Island and the Yukon. In the coming year, the agreements with Quebec, Ontario and British Columbia will end. During their lives, these agreements will have contributed substantially to the information available to the industry. The impacts are difficult to measure in the short term, but preliminary indications are that over the years the expenditure of $260 million by the federal and provincial governments on the MDAs will lead to developments and benefits to the industry significantly in excess of the expenditure.

The federal budget of April 1989 established new funding for regional development across Canada. Some of these funds will flow into renewed MDAs. The process for establishing priorities for the expenditure of this money and the negotiation of some MDAs was well under way at year-end.

In the following pages, the Regional Outlook looks at environmental issues of concern to the mineral industry as well as significant happenings and developments related to the mineral economies of each of the provinces and territories.

ENVIRONMENTAL ISSUES

In 1989, the Canadian mineral industry took a number of significant initiatives in the environmental field.

At the Mineral Outlook Conference in May, the Mining Association of Canada (MAC) announced its Environmental Policy. The policy, adoption of which is a condition of membership in MAC, commits companies to the concept of sustainable development which requires balancing good stewardship in the protection of human health and the natural environment with the need for economic growth. MAC is following up the policy by drafting an Environmental Code of Practice. The MAC Environment Committee, made up of officers of member companies who have responsibility for corporate environmental practice, has spearheaded the policy initiatives and is embarking on discussions with government agencies and interest groups.

At the Mines' Ministers Conference in Sudbury in August, MAC released the result of an Angus Reid public opinion survey which it commissioned to provide a basis for developing a public relations strategy. The survey showed that about 35% of those surveyed are generally sympathetic to the mineral industry, about 20% are unalterably opposed to it and the remainder are concerned about its environmental and socio-economic impacts but are willing to listen to both sides of the debate. MAC intends to use information gathered in this poll when developing a communications strategy to inform the public about mining and the environment.

Roy Aitken, Executive Vice-President, Inco Limited and an outspoken advocate of environmental responsibility by industry, was named to the National Round Table on the Environment. He is also a member of the Environment Committee of the Business Council on National Issues. Most of the provinces have also established Environmental Round Tables in line with the recommendations of the report of the Canadian Council of Resource and Environment Ministers (CCREM).

The mineral industry, through MAC, is cooperating with the Canadian Council of Ministers of the Environment (CCME) which is attempting to develop a set of broadly applicable industrial decommissioning guidelines.

Energy, Mines and Resources Canada (EMR) continued to review its activities to identify priorities for environmental initiatives. EMR will devote resources in the earth sciences and energy sectors to study environmental issues such as changes in the composition of the atmosphere, and to present policy options to deal with the possible national and global impacts of a warmer climate.

A sub-committee of the federal-provincial Intergovernmental Working Group on the Mineral Industry (IGWG) continued to work on the economic and policy aspects of controlling acid discharge. Using existing technology, industry estimates that it would have to spend $150 million per year over the next twenty years to bring the problem under control. Industry and several provincial governments have identified funding for the Mine Environment Neutral Drainage (MEND) research. The Canada Centre for Mineral and Energy Technology (CANMET) is project co-ordinator. Eleven MEND projects were initiated in 1988/89 with a total budget of $1.49 million, of which $835 000 is the federal share. Provincial and industry shares will increase in subsequent years as projects now being considered are initiated.

EMR manages mineral resources in offshore areas of federal jurisdiction for which the Minister of EMR has administrative responsibility. The Ocean Mining Division of the Mineral Policy Sector (MPS), in cooperation with the provinces, other departments and interested parties, is developing an action plan that will ensure that future resource extraction takes place in a manner that will take into account the natural environment and, in particular, the protection of our fisheries resource. (The legislation is one part of a comprehensive action plan for Fisheries and Environmental Protection.) Other aspects of the action plan focus on the need for an integrated approach to resource management, a strong environmental assessment and review process, and operational management of ocean mineral development that will ensure a cradle-to-grave approach. Consultation with all interested parties will take place before any legislation is proposed.

The comprehensive approach that is being taken by MPS in managing offshore minerals is exemplified by the development of a geographic information system, called Integrated Resource Management Information System (IRMIS). IRMIS has been developed as a result of EMR's commitment to protecting Canada's fisheries and the need to integrate economic and environmental information at very early planning stages. It also reflects the department's determination to be a proactive player on environmental issues.

NEWFOUNDLAND AND LABRADOR

The mineral industry of Newfoundland and Labrador experienced another excellent year in 1989. The estimated value of mineral production is $959 million, an 11.1% increase over the 1988 value. The forecasted $788 million for iron ore in 1989 represents the highest value since 1984 and an increase of 13.3% over the previous year.

Increased interest in Newfoundland's mineral potential since the middle of the decade is felt to be a response to the definition of numerous targets for gold and base metal potential outlined by geological and geochemical surveys done under the Canada-Newfoundland Mineral Development Agreement (MDA) coupled with flow-through share financing and the opening up of new tracts of land for staking. Exploration expenditures peaked at $41.1 million in 1988, returning to a more sustainable level of an estimated $30 million to $35 million in 1989. Exploration diamond drilling in 1989, estimated at 95 000 metres (m), is down considerably from the 217 382 m of 1988, but is still 25% greater than 1987. Claim staking also reflects the buoyant Newfoundland mineral industry. New claims staked have risen from 4522 in 1983 to 26 199 in 1988 and are forecast for 20 000 in 1989. A series of successes by both junior and major companies has fuelled interest in Newfoundland as a province with a great diversity of geology waiting to be explored and exploited.

Increasing interest is being shown in the province's industrial mineral potential, due in part to various feasibility and market studies carried out under the economic development component of the MDA. For example, new interest is being shown in the silica deposits of western Labrador; the high-quality Newfoundland slates stand to benefit from identification of the resurgence in the construction industry of slate as roofing and flooring material; various limestone and dolomite quarries are being assessed; and mineral rights have been awarded for several high-quality marble deposits on the Great Northern Peninsula. An export aggregate operation is cited as a possible use for the Albright & Wilson Americas Inc.'s phosphorus plant at Long Harbour which closed in August. Provincial forecasted values for 1989 of mineral production of nonmetals plus structural materials is 9.32% of the total value of production, and almost equals the combined value of gold and zinc, 9.35%. Thus, the potential for growth and diversification into newly identified markets is recognized and promising. With its existing deep-harbour ports and strategic location on marine shipping routes, Newfoundland is well located to consider further expansion into European and North American markets.

Baie Verte Mines Inc. does not ship asbestos to the United States and hence will not be directly affected by the U.S. ban on asbestos announced in September. However, Newfoundland is concerned that other countries might follow the U.S. lead which could affect their established markets. The new wet process mill proposed for the Baie Verte operation is expected to add 15 to 20 years to the life of the mine.

A brief shutdown at the Hope Brook gold mine provided the opportunity to complete mill construction. Development of the underground mine was completed in the third quarter and now provides all mill feed. Earnings were affected by the lowered price of gold which will continue to be a strong factor in 1990. Indications of significant gold mineralization in the Cape Ray and surrounding areas help to maintain an air of optimism in the south and southwestern parts of the province.

Production at the Newfoundland Zinc Mines Limited's mine was sustained throughout 1989, in part by the increased price of zinc which was more than double the price when the mine re-opened in 1987. However, new reserves have not been found and the mine is expected to close early in 1990.

On October 12, 1989, An Act to Amend The Mineral Act, 1976 was passed which provides provisions and clarifications of The Mineral Act, 1976.

The $22 million, five-year MDA terminated on March 31, 1989. Terms for a renewed agreement were being finalized at year-end. The MDA was seen as a major catalyst in the development of the Newfoundland mineral industry over the past five years and prospects for the near future are extremely positive.

NOVA SCOTIA

In 1989, the value of mineral production, including coal, in Nova Scotia decreased by 2.3% from 1988 to $443 million.

Provincial authorities estimate that $15 million was spent on mineral exploration in 1989, down from the estimated $40 million of 1988. Exploration diamond drilling in 1989 totalled an estimated 30 000 m, down from 110 000 m recorded in 1988. Total new claims staked showed a significant decline to an estimated 10 500, compared to 18 922 the previous year. While this downward movement appears significant, it follows the 1989 national trend and is seen as a return to a more sustainable level of exploration activity in Nova Scotia. The revised mechanism for flow-through share financing and a weakened price in the gold market are cited as contributing factors to the slowdown in investor enthusiasm, the stabilizing factor for junior exploration companies. A total of 26 junior exploration companies was active in the province in 1989, as well as 16 major companies.

Gold exploration, while registering a slowdown after mid-year, focussed on re-evaluation of known gold occurrences. On a positive note, Orex Exploration Incorporated showed encouraging results from its Goldboro gold deposit at Upper Seal Harbour and, after an extremely successful financing program, is continuing underground exploration and development. Success at the Orex property could stimulate new and renewed investment in gold exploration.

As the geologic database expands, favourable targets are being identified for base-metal exploration. Particular interest is being shown in the re-evaluation of base-metal properties in the Cape Breton Highlands; the source of zinc float in the area of the Gay's River property; lead/zinc deposits in the Windsor Group as well as manganese in the Windsor limestones; and additional reserves of tin, copper and zinc in the Yarmouth area. Nova Scotia deposits carry different economic parameters than the higher grade and volume required of deposits in northern Canada, and producers consider the advantages of geographic location for marine shipping and an excellent infrastructure system.

Following dewatering of the Gays River mine and successful test mining, Westminer Canada Limited halted gold development activities at Forest Hill and Beaver Dam and converted the Gays River mill back to zinc-lead processing. Concentrate production is scheduled to begin in January 1990.

However, it is the industrial minerals, along with coal, which continue to be the mainstay of the Nova Scotia mineral industry. Industrial minerals accounted for $194 million in 1989, a modest decrease of 2.4% over 1988 and represent 43.9% of the total value of mineral production, including coal. Opportunities exist to benefit from new uses for some minerals and to take advantage of value-added markets. For example, increased demand is anticipated for limestone markets to counteract acid rain legislation. An "agricultural gypsum" product, where gypsum mixed with irrigation water can be applied to crops and orchards, has been developed in response to a water penetration problem. Abundant Nova Scotia peat reserves are being developed. Use of anhydrite in mine support is in the underground testing stage. At The Canadian Salt Company Limited mine, a self-unloading converted lake boat is now capable of moving significantly larger shipments of salt out of the Pugwash harbour. Construction of Louisiana-Pacific Corporation's fibre-gypsum board plant at Point Tupper is to be completed early in 1990. We are seeing a willingness on the part of the industrial minerals industry to respond to new, more readily available technology to develop new value-added markets and to challenge established markets further afield.

Nova Scotia coal production increased 1.0% over 1988 to 3.6 Mt for a value of $207 million, representing 46.8% of the total value of mineral production. Cape Breton Development Corporation (CBDC) experienced an unsettled year of union, financial, environmental and political disputes. Conversion of the Lingan mine to retreat mining as a means of extending the life of the mine was still being discussed at year-end. In September, a Japanese company was awarded a contract to build a 154-MW power station at Point Aconi in Cape Breton. The project will be subject to new provincial environmental legislation that came into effect in July. Westray Coal Inc. resumed tunnelling operations at its Pictou County mine site in early 1990, following clarification of federal financial assistance. The mine is to supply low-sulphur coal to the power-generating plant scheduled to open at Trenton by the fall of 1991.

Fundy Gypsum Company Limited has filed environmental assessment reports as a prerequisite to development of the Dutch Settlement deposit. Production is anticipated in three to four years.

The five-year, $26.945 million Canada-Nova Scotia Mineral Development Agreement (MDA) terminated on March 31. Federal, provincial and industry support for the MDA was extremely positive. Negotiations for a renewed agreement were ongoing throughout 1989.

NEW BRUNSWICK

In 1989, the value of mineral production, including coal, decreased over 1988 by only 0.1% to $910 millio[illegible] Zinc showed an increase in value of 12.5% to $486 million, reflecting both price and volume improvements over 1988.

Preliminary 1989 exploration expenditures, based on the value of assessment work received, are estimated by the provincial government to be close to $20 million compared to $8.4 million for the previous year. Exploration in 1989 centred on both base metals and gold, particularly in the Bathurst area. Spurred on by successes of both major and junior companies, the momentum continued throughout the year. In November, announcement by Brunswick Mining and Smelting Corporation Limited of a significant base metal intersection maintained enthusiasm, particularly for zinc. The total number of claims at year-end was 8737 with claims in good standing at 30 895, the largest figure since 1966. The buoyant optimism is expected to continue into 1990.

As an indication of the emphasis being placed on the further growth potential and expanded mining opportunities in New Brunswick, the provincial premier appointed a Minister of State for Mines within the Department of Natural Resources and Energy, effective in mid-June.

Bulk zinc/lead concentrate was produced through the winter at the Caribou mine of East West Caribou Mining Limited. The mine was officially opened in June; however, financial problems led to a mine shutdown, still in effect at year-end. Brunswick Mining and Smelting Corporation Limited is producing from the Stratmat deposit and the "B" zone, and processing through the re-opened Heath Steele mill. Also in the Bathurst area, Marshall Minerals Corp. is awaiting approval of its submission regarding Environmental Impact Assessment (EIA) screening in order to continue development of its Restigouche base metal and silver property. NovaGold Resources Incorporated opened its gold and silver operation at Murray Brook in October.

Citing deterioration of world antimony prices, Dominion Explorers Inc., operators of Canada's only antimony mine, announced plans in December for a shutdown in January 1990 of the Durham mine. Alternative uses for the property are under consideration.

NovaGold Resources Incorporated has optioned the Mount Pleasant tin-tungsten mine, hoping to solve the complex geology and metallurgy of the deposit and recover the tin. The former tungsten producer closed in 1983, largely the result of falling tungsten prices.

Thus, we are seeing new mine/mill operations appearing in a province long known for its base and precious metal resource potential. Continued exploration and technology transfer combined with firm base-metal prices are providing a scene of optimism which is expected to continue into 1990. However, it is apparent once again that the success of a mining venture is strongly contingent upon international commodity prices and sound financial management.

Industrial minerals such as potash, gypsum, building stone, aggregates and peat moss are a major component of the New Brunswick mineral industry and accounted for about 26.0% of the total value of mineral production in 1989.

The five-year, $22.3 million Canada-New Brunswick Mineral Development Agreement (MDA) terminated in 1989. Negotiations for a new mineral agreement continue.

QUEBEC

In 1989, the value of mineral production in Quebec was $2.8 billion, representing an increase of 3.7% over 1988. This situation results mainly from increases in the production of zinc, copper and iron ore. However, the value of the precious metal production diminished when compared to 1988 levels.

Exploration expenditures are estimated to reach $215 million in 1989, representing a decrease of 41% from the previous year. The actual slowdown began in March of 1988 and the trend continued through 1989. The softening of the price of gold, the lingering effects of the 1987 stock market crash and the revised mechanism of the flow-through share program are factors contributing to the decrease in exploration investment. The exploration industry, especially the junior sector, is not operating at its full potential which impacts to some degree on the economic well-being of small communities. Although this reduced activity is viewed as significant, the exploration activity in Quebec nevertheless continues at a reasonably high level. Contrary to the previous years, exploration is no longer channelled only to gold but includes increased activity in the search for base metals.

A highlight of 1989 was the discovery by Louvem Mines Inc. and Aur Resources Inc. of the world-class polymetallic deposit in Louvicourt Township, in the Val-d'Or area. However, progress has been slowed somewhat due to the dispute settlement regarding Louvem's share in the property. Also of major importance was the discovery of the VSM Exploration Inc. base-metal deposit on the Grevet property in Quevillon near Chibougamau. The proven reserves of 6 Mt would guarantee the life of the mine for ten years. A pre-feasibility study is now under way. The Mazarin graphite deposit in the Fermont region constitutes another major discovery made during the year. Development is progressing well and the company is planning to bring the mine into production by January 1991. The realization of this project would contribute to a diversification of the mineral economy of the Fermont region, which presently is dependent on a single commodity, iron ore. Potential markets for the Mazarin graphite would be the United States, Japan and some European countries (West Germany, England and Italy) for use in the refractory, steel and automotive industries.

On July 6, Minnova Inc. inaugurated its Ansil mine, a high-grade copper deposit in the Rouyn-Noranda area, thus reducing Noranda Inc.'s dependence on imported feed. The concentrate generated by this new mine is processed through Noranda's smelting facilities in Rouyn and the smelter output, anode copper, is shipped to Montreal East for refining at Noranda's world-scale copper refinery. The Mobrun polymetallic mine of Audrey Resources Inc. and Minnova Inc., also near Rouyn-Noranda, returned to production following the completion of the new 1100 t/d mill. Noranda's copper mine in Murdochville, Mines Gaspé, resumed activities during 1989, thereby improving the employment situation in the Gaspé region. Other mines such as the Pascalis gold mine in the Val-d'Or area and the Beauchemin gold mine in the Rouyn-Noranda area were brought into production. It is believed that a similar trend of mine openings will continue in 1990.

The asbestos industry in Quebec is facing more difficult times. The phase-out and ban ruling issued by the EPA is totally unfavourable to the industry, despite the strong actions taken by the various asbestos producers. A gradual erosion of the volume of production is foreseen for the next few years as a decision from the U.S. Court of Appeal concerning this ruling is not expected until late 1991.

The $107 million Canada-Quebec Mineral Development Agreement (MDA) is in its final year. Approximately $20 million was spent in 1989 with funds now totally committed to various projects eligible under the eleven programs of the agreement. Of special interest was the addition of a Technological Program to provide assistance to mining companies for research projects conducted either by independent specialized firms, universities or government research centres. This Program also provided financial assistance for the set-up in Montreal of the CCARM (Centre canadien d'automatisation et de robotique minières), a research centre to study automation and robotics in mining. The Technical Economic Studies and Experimentation Work Program attracted the attention of companies interested in commodities such as granite, peat and magnesium.

The Financial Assistance Program for Prospecting in the Bas-Saint-Laurent and the Gaspésie is proving successful. A considerable number of gold and base metal occurrences have been identified. Of particular interest was the discovery of a promising gold-stibnite occurrence in the St-André de Restigouche area.

ONTARIO

Total mineral production in Ontario was $7.3 billion in 1989, an increase of 6.0% over the previous year. Increases in value were registered by most of the more important commodities, namely nickel, gold, copper, zinc and uranium, which collectively accounted for 69% of total provincial output. However, it was price, rather than volume, changes that played the greater role in year-over-year comparisons. Higher prices for nickel, the commodity with the highest value of production, enabled a 2.3% increase in output to provide a 16.5% increase in total value. For gold, the second most important commodity in Ontario, the situation was reversed; a much lower average price meant that an increase in volume of 29.1% resulted in only an 8.3% rise in the value of output in 1989, to $1.2 billion.

Exploration activity was down sharply in 1989, by as much as 40% in some regions of Northern Ontario, it is estimated. This drop in activity, a reflection of a lower gold price and changes in flow-through share regulations, represents a large decrease in exploration by junior companies, compared to the seniors.

Industry spokesmen have noted that the discovery of nonferrous metal reserves has not kept pace with depletion and that, unless more are discovered, Canada's role as an international metal supplier will be in jeopardy. Their concern is underscored by the fact that all but one of the new mines to start operations in Ontario in 1989 were gold mines. The exception was the small Redstone nickel mine near Timmins. High nickel prices also led to the reopening of the Shebandowan copper-nickel mine west of Thunder Bay.

Inco Limited announced near year-end that the company will spend $179 million to bring on-stream the first new mine in 20 years at Sudbury. The mine, which will be twice as productive as the Inco average, will employ about 200 people. Production, expected to amount to about 18 000 t/y of nickel and 9000 t/y of copper, is scheduled to start in 1993.

In the face of the downturn in exploration, two new incentive programs to encourage mineral exploration, worth $5 million per year, were introduced by the provincial government in 1989. The Ontario Prospectors Assistance Program will make annual grants of $10 000 to eligible individual prospectors, and the Ontario Mineral Incentive Program will provide grants of 30% of exploration costs up to a maximum of $150 000 for companies not using flow-through share funding.

Bill 74, An Act to Amend the Mining Act, received third reading in the Legislature on December 6, 1989. It is the first major revision to the 1906 Mining Act and will ensure that mine closures are carried out in an environmentally sound manner; it will also make staking easier.

Geoscientific activity, mining research and studies on industrial minerals and their markets continued during the year under the $30 million Canada-Ontario Mineral Development Agreement (COMDA). The agreement ends March 31, 1990, but publication of results will continue during a wrap-up year.

MANITOBA

The value of mineral production in 1989, excluding fuels, is estimated at $1.7 billion, an increase of 3.7% over 1988, and is due mainly to continuing strong base-metal prices throughout most of the year. Nickel, copper and zinc remained the principal contribution to mineral output. The industry accounts for about 7% of the gross provincial product of Manitoba, directly employs about 4500 persons in mining and processing operations, and provides the principal economic base for many of the communities in northern Manitoba.

The developing gold sector was dealt a blow in 1989 with closure of the province's three gold mines. Higher gold prices will be needed to revive production. In 1990, therefore, the Manitoba industry will again be dominated by base-metal production.

Exploration expenditures are estimated by provincial authorities at about $35 million, down about 17% from 1988, considered to be partly as a result of lower gold prices for most of the year. However, this decreased emphasis on gold exploration was partly offset by increased base-metal exploration, particularly in the Flin Flon-Snow Lake belt. Exploration was also active in both the Lynn Lake belt and the Thompson Nickel belt. The number of claims recorded was down by nearly 40% to 1063. A strengthening of gold prices late in 1989 will likely lead to more gold exploration in 1990.

Two mines came on-stream during 1989. Hudson Bay Mining & Smelting Co., Limited (HBMS) began production at its Chisel Lake zinc mine in early 1989 and, in late 1989, Inco Limited re-activated its Birchtree nickel mine, southwest of Thompson. However, the three Manitoba gold mines closed during 1989, due mainly to soft gold prices during the first ten months of the year, coupled with higher-than-estimated production costs. Pioneer Metals Corporation shut down its Puffy Lake gold mine in May, and later in the year operations were suspended at both the Tartan Lake mine owned by Granges Inc. and the MacLellan mine owned by LynnGold Resources Inc. which filed for bankruptcy at year-end. The closure of the MacLellan mine had a devastating impact on the town of Lynn Lake where most of the mine's workforce live. The province announced that it would help employees with relocation costs and provide the town with funds to maintain essential services at least until the spring of 1990.

In October, the Minister of the Manitoba Department of Energy and Mines released a Green Paper outlining proposals for the new Mining Act. It is expected that new legislation will be introduced in 1990 following review and comments by the Manitoba mineral industry.

The five-year, $24.7 million federal-provincial Mineral Development Agreement (MDA) came to a close in 1989. The MDA has contributed to the strengthening of the exploration and mining sectors through the many projects carried out during the term of the agreement. Many of the completed MDA geoscience projects were highlighted at the "Annual Meeting With Industry 1989" of the Manitoba Department of Energy and Mines in November. As well, in conjunction with this meeting, the completed research and technology projects carried out under the MDA were highlighted in a "Final Briefing Session." At year-end, discussions were under way between federal and provincial officials concerning renewal of the MDA.

SASKATCHEWAN

The value of nonfuel mineral production in 1989 is estimated at $1.5 billion, a decrease of 13.5% from 1988. Potash and uranium continued to account for the bulk of production even though Cameco - A Canadian Mining & Energy Corporation's Cluff and Rabbit Lake mills were shut down for part of the year. The industry accounts for some 6.5% of gross provincial product and approximately 5200 persons are employed directly in the mineral industry.

Exploration expenditures are estimated at $85 million, down some 20% from 1988, due principally to a significant decline in gold activity resulting from lower gold prices. However, uranium exploration activity increased even though uranium markets remained soft. Although gold exploration activity declined by almost half in 1989, many companies were still active, particularly in the La Ronge, Glennie and Flin Flon areas.

Most base metal activity was centred in the Flin Flon area. The zinc-copper Hanson Lake deposit, discovered in 1988 and owned by Cameco and Trimin Resources Inc., underwent considerable development work during the year. A pre-feasibility study done by Cameco indicated that a 27 000 t/d mining and smelting operation would have a capital cost of some $89 million.

The Jolu mine, 75 miles northwest of La Ronge, owned by Corona Corporation and International Mahogany Corp., was officially opened on May 15, 1989, although the first gold bar was poured in November 1988. At year-end, Cameco announced that it had acquired an 80% interest in the Forks Lake-Transom Lake gold properties. Cameco expects to put the property into production in early 1990 and has arranged to re-activate the Star Lake mill to process the ore.

The interest in diamonds intensified in 1989 following the discovery of kimberlite in mid-1988 in the Prince Albert area. Nine kimberlite occurrences have now been identified with microdiamonds having been found in three of them.

The $6.38 million Mineral Development Agreement (MDA) terminated in 1989. The five-year, federal-provincial agreement has provided significant results for the benefit of the exploration, mining, processing and marketing sectors of the mineral industry. Discussions for a renewed MDA were being held at year-end.

ALBERTA

In 1989, the value of mineral production was up 7.6% to $16.2 billion. Included in this amount is $15.5 billion for mineral fuels of which coal accounted for $503 million. Sulphur accounted for $400 million.

The record 1988 value of coal production from exporting mines in Alberta was surpassed again by the value of production in 1989. Total tonnage of coal produced increased by about 5% and a further increase is likely next year.

Production of elemental sulphur, a by-product of sour natural gas and oil sands petroleum production, decreased 15% to 4.8 Mt in 1989. New sour natural gas, oil sands and heavy oil projects are expected to come on-stream in the medium term, and will generate additional tonnages of elemental sulphur, offsetting the depletion of aboveground inventories and declining reserves from established gas fields. In the future, sulphur may become the primary product from some ultra-sour gas wells if the Bearberry demonstration project, due for completion by 1995, successfully demonstrates the feasibility and profitability of this type of production. As elemental sulphur production is dependent on oil and gas production and prices, the expectation is that increased exports of gas to the United States will help Alberta maintain its position as a major supplier in the world sulphur market.

BRITISH COLUMBIA

In 1989, the value of mineral production was up 3.8% to $4.1 billion due largely to increased value of fuel production. About one half of the total is attributable to mineral fuels (including $976 million for coal). Almost half of the remainder results from copper production. Additional values come from gold, zinc, silver, molybdenum, lead, antimony and cadmium.

The value of metal production fell in 1989 by about 2.5% as a result of lower prices for gold and silver and decreased production of copper and lead. Labor strikes affected production at the Highland Valley copper mine.

The mineral industry is a large contributor to the British Columbia economy and provides direct employment for approximately 11 700 people in operating mines. In this respect, new mines which opened in 1989 such as the Samatosum mine (Thompson-Okanagan), Golden Bear (Telegraph Creek), Lawyers (Toodoggone), and Premier (Stewart) have helped increase and maintain employment in areas away from cities.

There were labour strikes at the Fording River, Line Creek and the Quintette Coal Limited Tumbler Ridge coal mines, however, production remained the same due to continued strong international demand for coking coal. The industry received higher prices in U.S. dollars in 1989, but the stronger Canadian dollar will leave the mines in roughly the same relative position as 1988. Demand for British Columbia coking coal should remain strong as long as the world demand for steel continues to be firm.

The British Columbia and Yukon Chamber of Mines' preliminary estimate is that about $140 million to $150 million was spent on exploration in British Columbia in 1989. This expenditure is lower than the previous year due to difficulties experienced by junior mining companies in raising money for grass-roots exploration. Work focussed on properties in the more advanced stages of exploration and there was a trend to increased levels of work on base-metal projects. Encouraging results continue to be reported from projects across the province, such as those in the northern part of the province near Eskay Creek (gold), Windy Craggy (copper-gold-cobalt), Mount Milligan (copper-gold), Cirque (lead-zinc-silver) and in the southeastern part at Mount Polley (copper-gold). The mineral industry can be expected to continue to be a major contributor to the provincial economy.

In 1989, the Government of British Columbia passed three new pieces of mining legislation: a revised Mines Act, a Mining Right of Way Act and a Mineral Tax Act.

The Mines Act covers activity related to the exploration, development and production of coal and other minerals, including industrial minerals, sand and gravel. The Act also streamlines the mine project review process and regulation of operations from design to closure. It includes measures for health and safety aspects of mining operations, and for the reclamation of land and water-covered areas on closure. A labour, industry and government committee is drafting a Health, Safety and Reclamation Code for this Act. This code will replace the Mines Regulation and Coal Mines Legislation.

The Mining Right of Way Act will resolve disputes on the right of way and the use of existing roads. It may also assign capital or maintenance costs of roads built by other parties.

The Mineral Tax Act, in effect January 1, 1990, combines mineral production tax regimes, simplifies administration and encourages investment in new mines. The system will give short-term tax relief to coal mines.

The British Columbia Mine Development Review Process (MDRP) approved in principal nine projects, including the Snip project near Stewart. Six regional committees now review and approve small local proposals. As well, the Mine Development Steering Committee is working to make the review process more efficient.

The Canada-British Columbia Mineral Development Agreement (MDA) will expire in March 1990. Work under the MDA serves as a catalyst to stimulate the mining industry to create a positive and lasting impact on the British Columbia economy. Projects have included geoscience mapping and research, assistance to alleviate environmental impacts of tailings, transportation studies and work on industrial minerals such as a phosphate resource study.

NORTHWEST TERRITORIES

In 1989, the value of mineral production, including fuels, was up 20% to $1.14 billion mainly as a result of higher prices for zinc and lead and increased fuel production. The value given for mineral production is actually the value of shipments (actual production during the year was significantly lower) and includes the value of lead and zinc concentrate shipped from the Pine Point mine which was closed in 1988. As well, the limited shipping season for lead and zinc from the northern mines means that the value of mine production in the short term will be different than the value of shipments.

A preliminary estimate made by the Northwest Territories Chamber of Mines indicates that exploration expenditures in the Northwest Territories have decreased 30% to 40% to an estimated $60 million to $70 million. Exploration was concentrated mainly on gold projects in the western portion of the Territories. Because of the distances involved for the transportation of concentrates, there was only a slight increase in exploration for base metals.

Work on three main development properties was carried out in 1989. Development on the Tundra project continued until late in the year when the partners, Noranda Inc., TOTAL Energold Corporation and Hemlo Gold Mines Inc., decided that the grades of mineralization encountered in the underground work will not allow a production decision. The Neptune Resources Corp. Colomac mine is on schedule and is expected to open in early 1990. Urangesellschaft Canada Limited continued exploration as well as work towards obtaining regulatory approval for their Kiggavik (Lone Gull) uranium project. Federal Environmental Assessment and Review Process (EARP) hearings have been held in Baker Lake and the process is continuing.

Work under the Canada-Northwest Territories Mineral Development Agreement (MDA) continued in 1989. A total of 30 projects was carried out under the Geoscience Program. It is anticipated that companies will follow up results produced from some of these projects. The Northern Technology Assistance Program funded four projects in the Northwest Territories mines. The Northern Public

Information Program funded the production of material designed to provide information to the public on mining in the Northwest Territories.

Progress has been made towards settlement of the two land claims in the Northwest Territories. A large area of land withdrawn from staking in the Yellowknife area is expected to be released on the completion of selection of Dene/Metis land. This land withdrawal is part of the reason for decreased exploration expenditures. As well, the Agreement in Principle for the Tungavik Federation of Nunavut (TFN) land claims agreement has been initialled and is expected to be ratified by the federal government and the TFN early in 1990.

YUKON TERRITORY

In 1989, the value of mineral production was $540 million, up almost 10% from 1988, due in large part to the increased value of zinc production from the Faro mine. The placer industry had a good year with over 160 000 ounces of production reported to the Department of Indian and Northern Affairs by the end of October, the highest production reported since 1917 when 13 dredges were active. However, decreased gold prices offset the increased volume of production.

The Faro lead-zinc mine and the Ketza River gold mine operated throughout the year. Curragh Resources Inc. is developing the underground portion of the Faro deposit as well as nearby deposits on the Vangorda Plateau. Canamax Resources Inc. is presently mining oxide gold ore at the Ketza River gold mine and has explored around the mine for further ore reserves to extend the mine life.

Preliminary estimates from the Department of Indian and Northern Affairs indicate that approximately $18 million was spent on exploration in the Yukon in 1989, less than half that was spent in 1988. There has been an increased emphasis on base-metal exploration due to the higher prices for these metals. Projects in more advanced stages of exploration include the Hundere lead-zinc-silver deposit near Watson Lake, the Marg polymetallic massive sulphide deposit located northeast of Keno Hill and the Tom Deposit in the MacMillan Pass area where Cominco Ltd. has been working.

Land selection for the Council for Yukon Indians (CYI) land claim is continuing, and it is expected that a final settlement of this claim will be reached in 1990. The conclusion of these negotiations will mean that a major uncertainty in the Yukon has been resolved.

The Canada-Yukon Mineral Development Agreement (MDA) expired in March 1989 and was replaced by a one-year Canada-Yukon Economic Development Program which funded geological mapping and geochemical surveys carried out during the 1989 field season.

Note: *Information contained in this review was current as of mid-January 1990.*

LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1988 AND 1989

	Value of Production			
	1988^r	1989^p	Change 1989/1988	1989^p Proportion of Provincial Total
	($ million)		(percent)	
Newfoundland				
Iron ore	695.9	788.2	13.3	82.2
Zinc	52.6	64.4	22.4	6.7
Gold	x	x	x	x
Asbestos	26.9	24.2	-10.1	2.5
Stone, sand and gravel	25.9	22.2	-14.4	2.3
Total	863.7	959.2	11.1	
Prince Edward Island				
Sand and gravel	2.1	2.2	1.8	100.0
Total	2.1	2.2	1.8	
Nova Scotia				
Coal	215.9	207.3	-4.0	46.8
Gypsum	66.8	59.3	-11.1	13.4
Stone, sand and gravel	62.2	57.4	-7.7	13.0
Salt	x	x	x	x
Tin	x	x	x	x
Cement	x	x	x	x
Total	453.1	442.6	-2.3	
New Brunswick				
Zinc	431.6	485.6	12.5	53.4
Potash	x	x	x	x
Lead	75.6	71.2	-5.8	7.8
Silver	54.2	41.0	-24.4	4.5
Coal	33.5	33.8	0.8	3.7
Total	910.8	909.5	-0.1	
Quebec				
Iron ore	x	x	x	x
Gold	580.1	521.4	-10.1	18.5
Titanium dioxide	x	x	x	x
Stone	234.8	220.6	-6.0	7.8
Copper	150.3	205.9	37.0	7.3
Zinc	135.6	202.4	49.3	7.2
Total	2 711.4	2 812.4	3.7	
Ontario				
Nickel	1 742.5	2 029.9	16.5	27.8
Gold	1 080.5	1 170.5	8.3	16.0
Copper	904.2	892.9	-1.3	12.2
Zinc	540.0	578.2	7.1	7.9
Uranium	446.2	460.2	3.1	6.3
Cement	436.3	453.9	4.0	6.2
Total	6 896.3	7 308.8	6.0	
Manitoba				
Nickel	1 047.9	1 050.0	0.2	62.2
Copper	167.5	170.2	1.6	10.1
Zinc	88.8	156.8	76.5	9.3
Crude petroleum	78.6	88.5	12.6	5.2
Gold	77.3	60.7	-21.5	3.6
Total	1 626.6	1 686.8	3.7	

LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1988 AND 1989 (cont'd)

	Value of Production			
	1988f	1989p	Change 1989 1988	1989p Proportion of Provincial Total
	($ million)		(percent)	
Saskatchewan				
Crude petroleum	1 026.5	1 178.9	14.8	39.1
Potash	x	x	x	x
Uranium	572.5	529.5	-7.5	17.5
Total	3 043.1	3 017.2	-0.8	
Alberta				
Crude petroleum	7 710.7	8 960.5	16.2	55.3
Natural gas	4 584.5	4 420.6	-3.6	27.3
Natural gas by-products	1 542.4	1 579.0	2.4	9.7
Coal	458.9	503.0	9.6	3.1
Sulphur, elemental	419.5	400.8	-4.5	2.5
Total	15 062.0	16 207.2	7.6	
British Columbia				
Copper	1 137.9	1 113.9	-2.1	27.2
Coal	974.4	976.5	0.2	23.9
Natural gas	378.0	504.9	33.6	12.3
Zinc	236.1	282.5	19.6	6.9
Crude petroleum	206.0	236.9	15.0	5.8
Gold	226.0	210.8	-6.7	5.2
Total	3 943.1	4 091.2	3.8	
Yukon				
Zinc	237.9	341.6	43.6	63.3
Lead	x	x	x	x
Gold	87.4	80.5	-7.9	14.9
Silver	42.6	13.4	-68.6	2.5
Total	492.2	539.9	9.7	
Northwest Territories				
Zinc	537.8	728.4	35.5	63.6
Gold	205.5	174.8	-15.0	15.3
Crude petroleum	123.9	170.4	37.6	14.9
Lead	52.2	39.0	-25.3	3.4
Total	956.9	1 144.7	19.6	
Canada				
Crude petroleum	9 167.9	10 668.5	16.4	27.3
Natural gas	5 207.1	5 222.0	0.3	13.3
Nickel	2 790.4	3 079.9	10.4	7.9
Zinc	2 264.6	2 843.6	25.6	7.3
Copper	2 393.6	2 414.6	0.9	6.2
Gold	2 332.0	2 297.7	-1.5	5.9
Coal	1 804.3	1 835.5	1.7	4.7
Natural gas by-products	1 593.6	1 635.1	2.6	4.2
Iron ore	1 323.2	1 492.9	12.8	3.8
Cement	971.3	998.2	2.8	2.6
Total	36 961.2	39 121.9	5.8	

f Final; p Preliminary; x Confidential.

Labour and Employment 1989

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OVERVIEW

In a year that could be characterized as generating mixed results for the minerals and metals sector, labour market developments in 1989 also defied easy generalization. Overall, employment levels are estimated to have remained stable during the year, but a closer look reveals that employment growth in most segments of the industry was negated by a sharp drop in gold employment. Forecasted direct employment in mining (Stages I and II excluding oil and gas[1]) for 1989 was 151 283 jobs, down a slim one third of one percent from 1988.

This chapter offers a closer look at labour market developments in the minerals and metals industry, including an overview of the industrial relations scene, compensation trends, plus selected safety and health highlights. Major legislative developments at the federal level are also noted.

LABOUR MARKET DEVELOPMENTS

The supposition that the mining industry has achieved a degree of stability after the rationalization during the early 1980s is borne out by recent employment figures. Year-to-year movements in total employment (Stages I and II) have moved within a range of less than 3.5%, in the neighbourhood of 151 000, for each of the four years to the end of 1989. A full assessment of employment stability would not be possible until the industry has moved through a complete mineral cycle.

Focusing on 1989, employment increased slightly for most commodities, but once again gold stood out as an exception. In sharp contrast to 1988, gold employment registered not growth but contraction. Employment in gold mines fell from 12 068 in 1988 to an estimated 11 000 in 1989, a decrease of nearly 9% (Figure 1).

Despite the gold situation, employment in metal mines generally is forecast to grow in 1989, the second straight year of small increases. Of note is the growth in base-metal employment (SICs 0612, 0613, 0614) from 23 096 in 1988 to 23 982 in 1989, an increase of 3.8%, despite weakening prices during the year for copper, nickel and zinc. Total metal mining employment is forecast to be 47 723 in 1989.

Employment in the nonmetals also increased slightly in 1989, and is forecast to total 11 711. Interestingly, coal employment in 1989 showed a return to 1987 levels of just over 10 400 after rising to 11 379 in 1988.

In the construction materials sector, employment is expected to be down for the first time since 1983. During the 1983-88 period, the number of people employed in sand and gravel as well as stone quarries rose from 3403 to 6058, some 78%. Employment slackened in 1989 to an estimated 5654, evidence of a general slowing in the economy.

Overall Stage I employment, forecast to be 75 542 in 1989, is down marginally (i.e. 1%) from 1988. In Stage II, employment in smelting and refining was up by nearly 1000 jobs to 30 462, while employment in iron and steel mills remained flat at just over 45 000. Total employment in the primary metals is estimated at 75 741 for 1989 (Figure 2).

As was the pattern in 1988, the number of mine openings in 1989 exceeded the number of closures. However, the number of mine closures was up significantly. The Department of Energy, Mines and Resources (EMR) estimates, on a preliminary basis, that 19 mines were opened across Canada in 1989 generating approximately 2500 jobs, while 10 mines closed with a loss of nearly 1300 jobs.

The notable feature of the list of indefinite closures in 1989 is that virtually all are gold or silver mines. The list includes two silver operations, United Keno Hill Mines Limited at Elsa, Yukon affecting 170 workers, and Agnico-Eagle Mines Limited at Cobalt, Ontario affecting 40 workers. Seven gold mines closed across Canada including: (1) the small Star Lake mine in northern Saskatchewan resulting in 35 layoffs; (2) the Schumacher mine owned by Giant Yellowknife Mines Limited at Timmins, Ontario (146 layoffs); (3) the Pioneer Metals Corporation operation at Puffy Lake, Manitoba affecting 125 workers; (4) the historic Kerr mine operated by Golden Shield Resources Ltd. at Virginiatown, Ontario (320 workers affected); (5) Bachelor Lake Gold Mines Inc. at Desmaraisville, Quebec (115 layoffs); (6) LynnGold Resources Inc.'s MacLellan mine at Lynn Lake, Manitoba (225 employees); and (7) the Tartan Lake mine owned by Granges Inc. located near Flin Flon, Manitoba (87 employees). Finally, Evans Coal Mines Limited at Inverness County, Nova Scotia closed in April 1989 affecting 35 workers.

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[1] Stage I is defined as the sum of metal mines, nonmetal mines, structural materials and coal. Stage II is defined as smelting and refining plus iron and steel mills.

COMPENSATION

Average earnings in mining are among the highest of all industrial classifications. For **1988**, average weekly earnings for hourly paid employees (including overtime) were $775.78 for metal mines and $655.89 for the nonmetals, in contrast to $544.76 in manufacturing and $562.69 in construction.

At time of writing, data for **1989** were available to the end of August. Over the one-year period ending in August 1989, average weekly earnings in metal mines were up 7.2%, by 9.2% in the nonmetals and by 6.3% in the coal industry.

The data indicate, in contrast to recent trends, that **real** wages increased in the sector for the period up to the end of August 1989. For the period August 30, 1988 to August 30, 1989, real wages in metal mining (based on the CPI) increased by 2.0%, in coal by 1.1% and in the nonmetals by 4.0%. Over the same period, real wages in all industries decreased slightly (i.e. by 0.2%).

In 1988, the last year for which data are available, average annual labour income in mining (wages and salaries plus employer contributions to benefit plans) was $45 632, still well above average labour income of $29 969 for all industries. These figures represent increases of 7.5% and 5.5%, respectively, over 1987 current dollar income.

INDUSTRIAL RELATIONS

By historical standards, the number of work stoppages in mining has been low in recent years, and the vast majority of contracts in the industry are signed without a work disruption. The year 1988 witnessed little change from 1987 in the number of stoppages, though the severity in terms of person-days lost was down by 30%. For all industries, the number of stoppages was down by over 16% from 655 to 550, perhaps belying the conventional wisdom that labour disputes would become more prevalent as workers sought to recover income lost during the recession earlier in the decade.

In **1988** there were 13 stoppages in mining; 9 in metals, 3 in nonmetals and 1 in quarries. There were 4481 workers involved and 160 014 person-days were lost. To place the time lost in context, it represents an estimated 1.4% of the total work time of unionized workers in the sector.

For **1989**, while aggregate data are not yet available, there were a number of strikes/lock-outs which attracted public attention, and the majority of disputes appeared to occur in British Columbia. Preliminary data (Table 1) show that there were five major disputes in British Columbia, two in Ontario, one in Quebec and one in Nova Scotia.

Effective wage increases in mining collective agreements averaged 6.1% in 1988, up from 3.3% in 1987. These increases exceeded the average increase for manufacturing, 4.6% and for all industries, 4.3%, by a significant margin. It bears emphasis that these data exclude non-wage benefits, which can range up to 40% of the value of total compensation.

EMR has done a preliminary analysis of 1989 collective agreements. The year saw important settlements in the coal and potash industries, but overall it was relatively quiet for bargaining. Average annual wage increases ranged widely, from 1-10%, but in general settlements appear to be trending slightly in excess of the rate of inflation. Improved pension provisions were a significant common feature among many of the agreements settled during the year. Once again in 1989, settlements tended to be at least two years in duration, and the average contract duration was 31 months.

SAFETY AND HEALTH

Mine safety and health was a top priority for workers, governments and the minerals and metals industry in 1989. Exhaustive efforts are made to prevent injuries and fatalities, and several jurisdictions (notably British Columbia, Yukon and the Northwest Territories) revised and updated mine safety and health legislation or administration during the year.

For 1988 (the most recent year for which complete data are available), statistics on time-loss injuries suggest that the number of serious accidents has held stable since 1986, despite industry growth and the opening of a considerable number of new mines. There were 4833 time-loss injuries in metal and nonmetal mines in 1988, up from 4766 in 1987. As illustrated in Table 2, this indicates a levelling off after a generally downward trend since 1982. There were 13.7% fewer time-loss injuries in 1988 than 1982.

Published preliminary statistics for 1988 indicate that there were 82 fatalities in mining (including quarries and oil wells). Of this number, 50 were the result of occupational injuries sustained during 1988 or earlier, and 32 were the result of occupational illnesses.

The fatality frequency rate was 0.44 per thousand workers in 1988, down from 0.6 in 1987 and importantly, the lowest rate ever recorded. By historical terms, this demonstrates substantial improvement, but rates during the latter part of the 1980s have remained generally flat. Fatality rates in forestry and fishing continue to exceed that of mining.

The EMR survey of provincial/territorial Chief Inspectors of Mines indicates that there were 36 mining fatalities in **1989**. This survey refines the published data somewhat, as it focuses on fatalities directly due to mining accidents, and excludes oil and gas. The number of 1989 fatalities is down from 44 in 1988, and compares favourably to the annual average for the 1979-89 period. Table 3 provides further details on 1989 fatalities, including breakouts by jurisdiction and mine type.

In cooperation with the Chief Inspectors of Mines, EMR is developing a National Mine Accident Data Base. The data base contains up to 50 pieces of information on each accident entered into the system, and is designed to provide a better statistical understanding of the various factors which contribute to mine accidents. At present, Canada's three largest mining provinces, Quebec, Ontario and British Columbia, are participating in the system, and work is ongoing to secure the participation of other jurisdictions.

Figure 3 provides a sample analysis from this prototype system. It shows that the two main types of lost-time accidents in the mining industry are the result of overexertion or as a result of the worker being struck by an object. For "struck by" accidents, one third result in a bruise or contusion, while 21% result in a fracture.

LEGISLATIVE HIGHLIGHTS

The federal jurisdiction for labour matters affecting the mining industry is narrowly defined. Responsibility for most labour legislation, including safety and health, industrial relations and conditions of work, rests with the provinces and territories. While there is a broad range of labour legislation across Canada, specific provisions vary widely across the jurisdictions.

Each year, governments enact a wide range of labour legislation that may impact on the mining industry. This section does not attempt to review all such legislation, but outlines developments at the **federal** level in 1989, with very brief reference to selected provincial initiatives.

Unemployment Insurance

Bill C-21, An Act to amend the Unemployment Insurance (UI) Act, received Third Reading in the House of Commons on November 6, 1989. The Bill contemplates an extensive overhaul of the unemployment insurance system in Canada.

Main features of Bill C-21 include a lengthening of the qualifying period for unemployment insurance benefits, coupled with a reduction in the maximum period over which benefits are payable. However, both of these features remain a function of the regional unemployment rate. In regions of low unemployment the qualifying period would be 20 weeks instead of 14, and the maximum benefit period would be set at 35 weeks. In high unemployment areas, workers would continue to qualify after 10 weeks of work, and could claim up to 50 weeks of benefits.

The amendments also contemplate sharply reduced benefits for workers who quit their jobs voluntarily or without "just cause." The rate of coverage would fall to 50% of insurable earnings, and the waiting period before the first benefit payment would be extended. Also, the system of maternity and sickness benefits under the Act would be overhauled to ensure equity and flexibility for parents. Finally, penalties for fraud under the UI Act would be increased substantially.

Savings realized as a result of these amendments would be redirected to skills training and related programs for workers who have lost their jobs. Funding available to retrain UI recipients would be increased by $350 million, and allocations for relocation assistance, self-employment and entrepreneurship programs would also increase.

Taxation of Northern Benefits

The Task Force on Tax Benefits for Northern and Isolated Areas, created in April 1988, submitted its report to the Minister of Finance in October 1989. The Task Force reviewed provisions under the Income Tax Act under which residents of isolated communities are eligible for residency deductions of $225 per month, $450 per month for those who own their principal dwelling, to a maximum of 20% of net income.

The Task Force has proposed revised boundaries for defining which communities qualify for these tax benefits. A contiguous Northern Zone, somewhat more restrictive than under the current system, was recommended. It was also recommended that the transition period, from the current system to the Northern Zone system, not exceed one year.

At time of writing, these recommendations have not passed into law, nor have they been adopted by the government.

Employment Equity

The second annual report under Canada's Employment Equity Act was submitted to Parliament in December 1989. Mining employers covered by the Act include the uranium mines, Cape Breton Development Corporation, Hudson Bay Mining and Smelting Co., Limited and Alcan Smelters and Chemicals Limited.

The data for 1988 contained in the report indicate slightly increased representation in the metal mining sector of each of the four designated groups (women, aboriginal peoples, disabled persons and members of visible minorities). Among reporting metal mines, employment of disabled and aboriginal peoples exceeded the national average, while employment of women and members of visible minorities remained well below the average for all industries.

As provided for in legislation, the Employment Equity Act will come under review for the first time in 1991.

Provincial/Territorial Developments

Several significant changes to labour legislation at the provincial and territorial levels took place in 1989. In the Northwest Territories, the Mine Safety Act and Regulations were overhauled. Also in the Northwest Territories, the Labour Standards Act was amended to improve notice-of-termination provisions, and special provisions for the Workplace Hazardous Materials Information System (WHMIS) were made under the Mine Safety Act. Also in the North, responsibility for safety and health was transferred from the federal government to the Yukon Department of Justice.

The Occupational Health and Safety and Mining Acts were amended in New Brunswick to update a number of regulations in a range of areas including noise, lighting and protective equipment. Several jurisdictions proceeded with WHMIS implementation as well as legislated increases in minimum wages. Finally, Alberta added the third Monday in February to its list of statutory holidays.

OUTLOOK

The rate of economic growth is widely expected to slow, albeit modestly, in 1990. The impacts of a weaker economy would be directly felt in the minerals and metals sector. Strengthening gold prices in late 1989 give cause for optimism for that sector, though base-metal prices are expected to be widely lower in 1990. In these circumstances, Stage I employment can be expected to decrease in 1990, though drastic reductions are not anticipated.

Employment in the iron ore sector will fall significantly with the closure in March 1990 of the Adams and Sherman mines in northeastern Ontario affecting nearly 700 workers. The strength of the construction industry, which will vary regionally, will be an important determinant of industrial minerals employment in 1990.

The collective bargaining calendar in 1990 will heat up again after a relatively quiet year in 1989. In light of the labour movement perspective on the

Goods and Services Tax and the Canada-U.S. Free Trade Agreement, as well as the buoyancy of the mining industry over the last two to three years, negotiations will bear close watching.

The long list of major collective agreements (i.e. covering more than 500 employees) expiring in 1990 includes the Iron Ore Company of Canada (IOC) in Labrador City; LAB Chrysotile Inc. at Thetford Mines, Quebec; Noranda Minerals Inc. at Noranda, Quebec; Brunswick Mining and Smelting Corporation Limited at Bathurst, New Brunswick; Giant Yellowknife Mines Limited, Placer Dome Inc., Denison Mines Limited and Rio Algom Limited throughout Ontario; Hudson Bay Mining and Smelting Co., Limited at Flin Flon, Manitoba; Cominco Ltd. at Kimberley, British Columbia; Westmin Resources Limited at Myra Falls, British Columbia; and Curragh Resources Inc. at Faro, Yukon.

This list of collective agreements represents only a fraction of expiring agreements in the industry. The calendar is particularly busy in Ontario and Quebec, and will be busy in the Stage II industries (smelting and refining and steel) as well. Patterns for the 1990s in both wage and non-wage compensation may well be set as a result of settlements in 1990, as negotiators attempt to reconcile pressures on employers to contain costs and labour demands for catch-up wage gains and improved benefits.

In addition to the iron ore mine closures, three additional indefinite closures have been announced for 1990 as of the time of writing. Brenda Mines Ltd.'s copper/molybdenum mine near Peachland, British Columbia will close in September 1990 affecting 420 people, the Sullivan lead/zinc mine owned by Cominco Ltd. near Kimberley, British Columbia is scheduled to close at the end of January 1990 resulting in 825 layoffs, and at Daniel's Harbour, Newfoundland, Newfoundland Zinc Mines Limited is scheduled to close in June 1990 affecting 150 workers.

Note: Information contained in this review was current as of mid-January 1990.

TABLE 1. LABOUR DISPUTES, 1989

Employer	Location	Products	Union[1]	Period of Work Stoppage	Employees Involved
NOVA SCOTIA					
Cape Breton Development Corporation (CBDC)	Glace Bay	Coal	IAM	January 25–April 1	140
QUEBEC					
Canadian Salt Company Limited, The	Îles-de-la-Madeleine	Salt	FMT	April 5–September 12	140
ONTARIO					
Falconbridge Limited	Nephton	Nepheline syenite	ECWU	March–June	90
St. Marys Cement Corporation	Bowmanville	Cement	CAW	March–May	86
BRITISH COLUMBIA					
Cheni Gold Mines Inc.	Smithers	Gold, silver	TRW, IUOE	April 5–June 28	80
Crows Nest Resources Limited	Line Creek	Coal	IUOE	August 5–September 24	364
Fording Coal Limited	Elkford	Coal	USWA	July 7–15	895
Highland Valley Copper	Logan Lake	Copper	USWA	July 6–October 19	1 209
Quintette Coal Limited	Tumbler Ridge	Coal	USWA	July 1–14	1 135

Sources: Labour Canada, Collective Bargaining Review; Canadian Labour View Reports.

[1] Acronyms:

CAW	National Automobile, Aerospace and Agricultural Implement Workers Union of Canada
ECWU	Energy and Chemical Workers' Union
FMT	Federation of Metal Trades
IAM	International Association of Machinists and Aerospace Workers
IUOE	International Union of Operating Engineers
TRW	Tunnel and Rock Workers' Union
USWA	United Steelworkers of America

TABLE 2. NUMBER OF TIME-LOSS INJURIES, MINING, 1982–88

	Mines, Quarries and Oil Wells	Metal and Nonmetal Mines	Mineral Fuels
	(SIC 051–099)	(051–059, 071–079)	(061–064)
1982	12 425	5 603	3 541
1983	11 717	5 114	3 153
1984	12 322	5 595	2 286
1985	13 471	5 411	3 175
1986	11 105	5 024	2 191
1987	11 103	4 766	1 931
1988	11 247	4 833	1 857

Source: Statistics Canada.

TABLE 3. FATALITIES IN THE MINING SECTOR[1], 1989

	Employer		Location			
Jurisdiction	Company	Contractor and Misc.	U/G	O/P	Other	Total
Newfoundland	1	0	0	1	0	1
Nova Scotia	0	0	0	0	0	0
Cape Breton Development Corporation	0	0	0	0	0	0
New Brunswick	2	0	2	0	0	2
Quebec	11[2]	1	6	1	5	12
Ontario	8	3	8	0	3	11
Manitoba	0	2	1	0	1	2
Saskatchewan	0	1	1	0	0	1
Alberta	0	0	0	0	0	0
British Columbia	2	4	5	1	0	6
Northwest Territories	0	0	0	0	0	0
Yukon	1	0	0	1	0	1
Canada Total	25	11	23	4	9	36

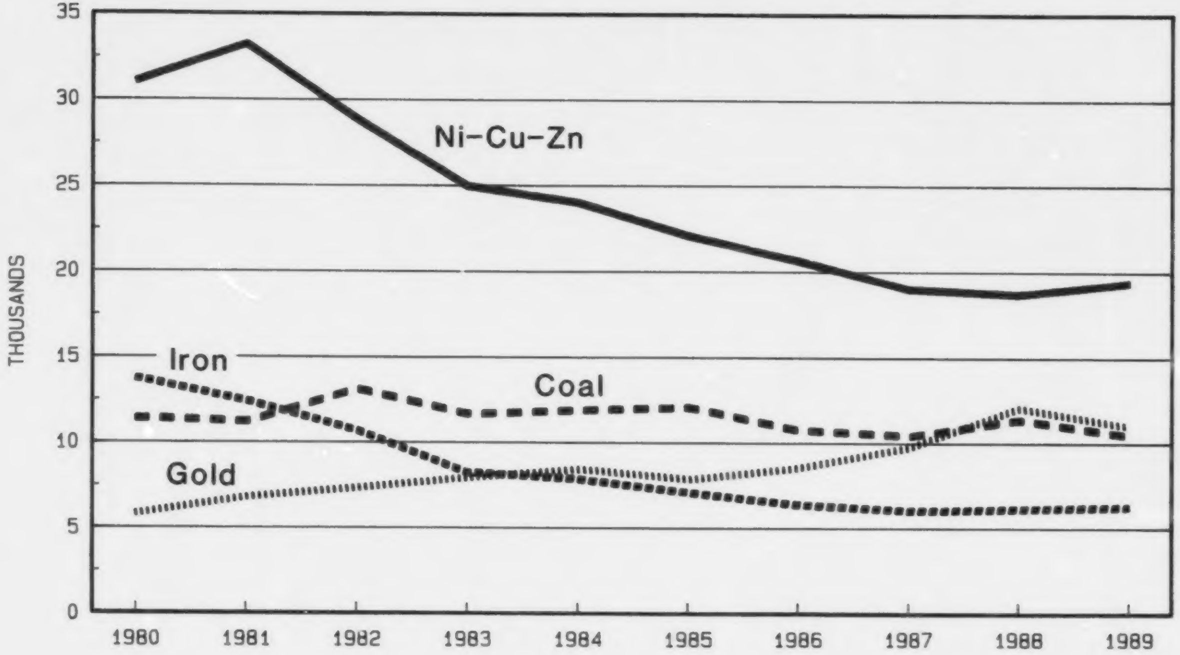
Source: Mine fatalities as reported by Chief Inspectors or corresponding authority of every mining jurisdiction in Canada. Compiled by EMR, January 1990.

[1] For the purpose of this table, the mining sector is understood to include quarries and sand pits with the exception of Newfoundland, New Brunswick and the Northwest Territories which have not reported under that category. [2] Of these fatalities, four were workers employed in quarries.

Note: The table provides the number of work-related fatalities in 1989 caused by a traumatic accident. It does not include deaths resulting from occupational illnesses. Also, off-property and commuting transportation accidents such as highway traffic accidents are not included.

Figure 1

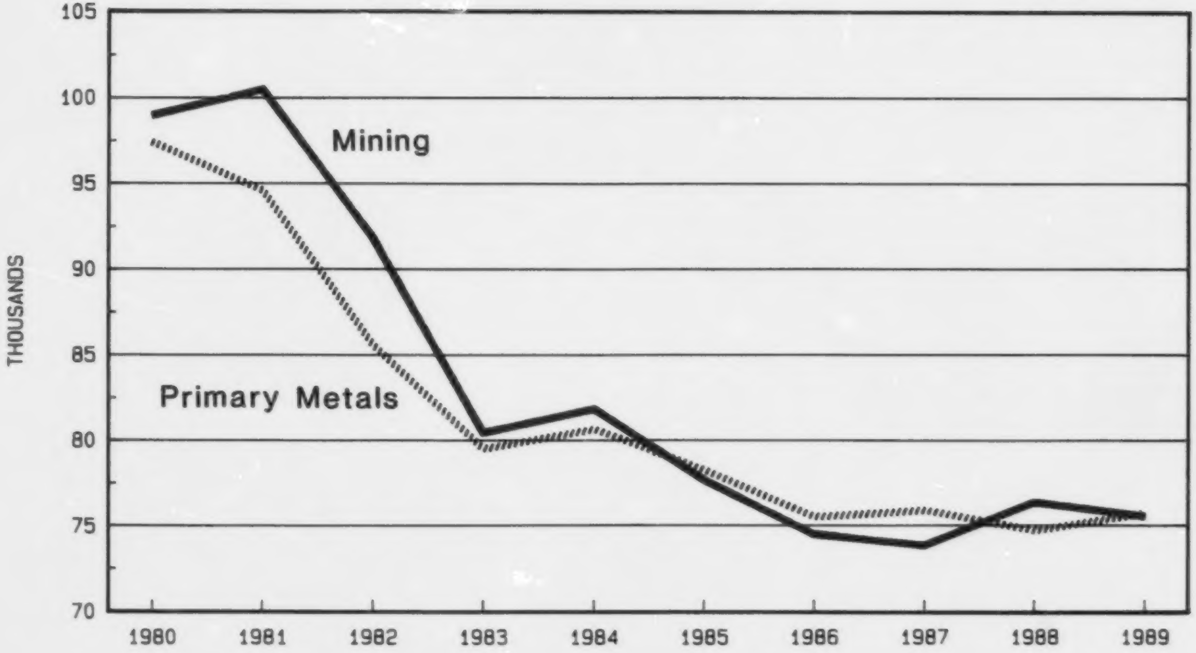
EMPLOYMENT BY COMMODITY
STAGE I: MINING



Sources: Annual Census of Mines for 1980-88 data; Energy, Mines and Resources Canada for 1989 forecast.

Figure 2

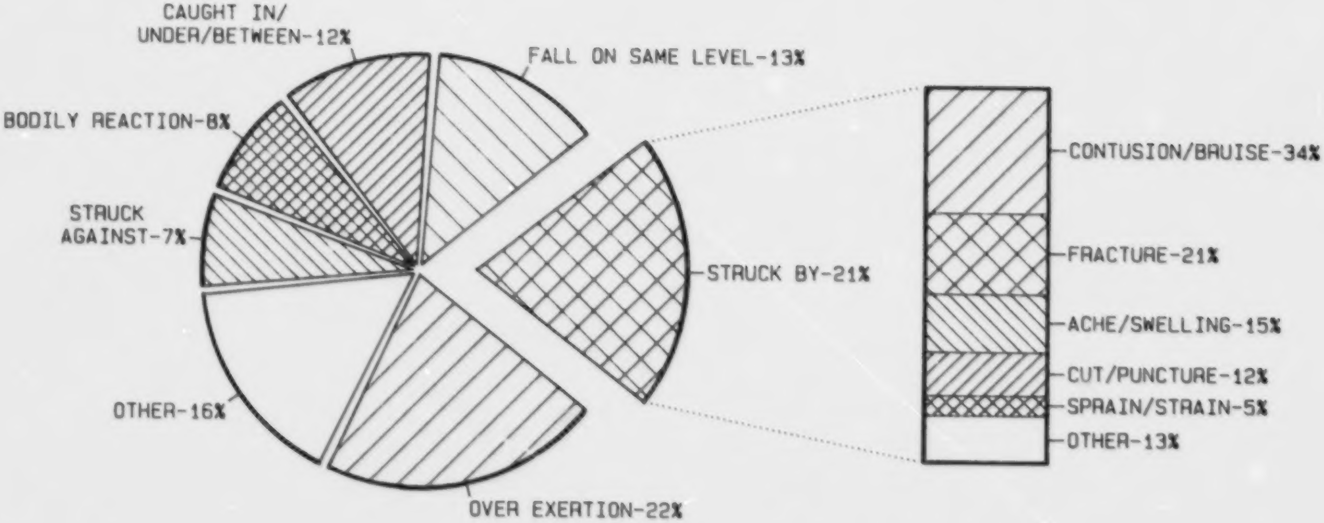
EMPLOYMENT
MINING AND PRIMARY METALS



Sources: Annual Census of Mines for 1980-88 data; Annual Census of Manufactures for 1980-86 data and Annual Survey of Manufactures for 1987-88 data; Energy, Mines and Resources Canada for 1989 forecast.

Figure 3

MOST FREQUENT TYPES OF LOST TIME ACCIDENTS, 1988
WITH NATURE OF INJURY FOR "STRUCK BY" TYPE



LOST TIME ACCIDENTS
BY TYPE

NATURE OF INJURY
FOR "STRUCK BY" TYPE

Source: National Mine Accident Data Base.

Canadian Reserves, Mine Investment, New Projects and Promising Deposits

1989

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RESERVES

Table 1 shows the levels of Canadian reserves of seven major metals over the period 1979-89, in terms of metal contained in ore. These reserves were computed on the basis of information provided by mining companies and they pertain to ore tonnages that, as far as could be determined, were known at a level of confidence equivalent to "proven" and/or "probable." Tonnages reported as "possible" are not included. Table 2 shows the distribution of reserves by province as at January 1, 1989.

While the term "reserves" is widely used to refer to that portion of mineral resources that, on a given date, is well delineated and considered economically mineable, the reserves in Table 1 and Table 2 are confined to those in producing mines and in deposits that have been committed for production. For other deposits, where concrete steps have not been taken by companies to prepare them for mining, judgments by outsiders regarding economic mineability would not form a consistent basis for reporting "reserves."

The quantities of reserves reported here cannot, by themselves, give any indication of whether or not Canada might be running out of economically mineable minerals. Future production will draw not only on the 1989 reserves, but also on additional reserves yet to be developed -- from new discoveries, from extensions to known orebodies and from known but currently marginal or uneconomic material. The Department of Energy, Mines and Resources' annual mineral bulletin[1] on Canadian mines deals with Canadian capability for metal production both from operating mines and from known deposits for which future production can be considered likely.

Gold

From 1988 to 1989, Canadian reserves of gold in mineable ore increased more than 9%, continuing the strong, uninterrupted growth of the past decade. New operations and new commitments to produce gold from conventional gold mines and as a by-product of base-metal mines (Table 3) were the largest contributors to this increase which took place mainly in Ontario and Quebec.

New conventional gold mining operations or commitments to production made during 1988 contributed some 164 t of gross additions to reserves; existing gold mines, 77 t; new mines that will produce gold as a by-product, 24 t; and existing by-product gold producers, a further 33 t. Mining companies reduced reserves in conventional gold mines by some 121 t, and those in mines producing gold as a by-product by another 12 t. New tailings reprocessing operations, which contributed about one third of all new gold reserves in 1987, were not a significant source of new gold reserves during 1988. After allowing for production during 1988, there was a net increase in reserves of gold of some 166 t from January 1988 to January 1989.

Mine by mine and province by province, there are considerable departures from national reserve trends. Reserves in most mines change slightly from year to year but, on balance, these changes cancel out in national totals. It is the relatively few mines with large changes that affect the overall direction of national trends. In the case of gold, most mines had relatively small changes in reserves from January 1988 to January 1989 (Figure 1). Nonetheless, large increases at relatively few operations resulted in a large net gain in Canadian gold reserves over the previous year.

By far the largest single gross contribution to the growth of Canadian reserves of gold during 1988 (almost 50 t) came from the first-time inclusion in national totals of Neptune Resources Corp.'s Colomac deposit in the Northwest Territories, which is expected to begin production by mid-1990 at a rate of some 200 000 oz. (6200 kg) per year. Also notable were additions resulting from the first-time inclusion in national totals of the Francoeur mine in

Quebec, owned by Rouyn Mining Resources Inc. and LAC Minerals Ltd. (20 t); the Premier mine in British Columbia owned by Westmin Resources Limited, Pioneer Metals Corporation and Canacord Resources Inc. (17 t); the Magino mine in Ontario owned by Muscocho Explorations Ltd. and McNellen Resources Inc. (15 t); and the Magnacon mine, also in Ontario, owned by Muscocho, Flanagan McAdam Resources Inc. and Windarra Minerals Ltd. (11 t).

The largest single decrease in gold reserves (some 26 t) took place at Corona Corporation's Nickel Plate mine in British Columbia where the average grade of ore was reduced considerably during 1988 with respect to that projected in the original production feasibility study, contributing to a reduction in the carrying value of the mine of some $108 million. Another significant decrease in gold reserves (17 t) was the result of the closure of Pioneer Metals Corporation's unprofitable Puffy Lake mine in Manitoba.

Of the total Canadian mineable reserves of gold as of January 1989, 76% occurs in conventional gold mines, 19% in mines where gold is produced as a by-product, and the remaining 5% in tailings and other gold-bearing rock waste that will be reprocessed (Table 4). More than 90% of the gold contained in ores produced from conventional gold mines is recoverable in concentrator products. Base-metal ores with minor gold content as well as old gold-mining waste yield only about half of their gold content. Overall, more than 80% of the gold now counted in Canadian reserves of mineable ore is expected to be recovered in concentrator products in the course of mining and processing.

Copper

Additions to Canadian copper reserves during 1988 were more than offset by production and apparent write-downs of reserves at some mines such that, on balance, Canadian copper reserves decreased 2% in 1989 compared with last year's revised totals. The largest single addition to copper reserves occurred at Teck Corporation's Afton operations where mining of the Ajax deposit began in early 1989. Other significant additions to Canadian copper reserves came as a result of the discovery of a new mineralized horizon at Noranda Inc.'s Murdochville townsite mine in Quebec, from changes made to the mining plan at BHP-Utah Mines Inc.'s Island Copper operations in British Columbia, and from the commitment to production in early 1988 of Hudson Bay Mining and Smelting Co., Limited's (HBMS's) new Callinan mine in Manitoba.

Molybdenum

Canadian reserves of molybdenum decreased about 3% from 1988 to 1989 because only about half of the metal produced during 1988 was replaced with new ore. The only operation to report net additions to reserves of molybdenum was BHP-Utah's Island Copper operation where one of the walls of the open pit previously thought to have reached its outer limit is being pushed back, and where it is planned to process mineralized material with a grade lower than that which was previously mined.

Lead

Canadian reserves of lead increased 4% from 1988 to 1989, the first annual increase in lead reserves recorded since 1982.

Tonnages for Curragh Resources Inc.'s Vangorda and Grum deposits in the Yukon Territory, which are substantially larger than those previously reported, were largely responsible for this increase. Curragh plans to produce from these two deposits starting in the early 1990s. Another major contributor to the growth of lead reserves during 1988 was the first-time inclusion in Canadian totals of the reserves in the Caribou deposit in New Brunswick which is owned by Bathurst Base Metals Ltd. and East West Caribou Mining Limited. Production from the Caribou deposit, which was discovered in the 1950s, began in late 1988. The impact of these additions to Canadian reserves would have been much larger had new ore been found to replace much of the lead that was mined elsewhere during 1988.

Zinc

For zinc also, reserves increased in 1989 (almost 2%), reversing the progressive decline that began in 1983. In addition to the Caribou mine in New Brunswick, two of HBMS's new mines in Manitoba included for the first time in Canadian totals (Chisel Lake North and Callinan) were significant factors in boosting zinc reserves. Nonetheless, much of the zinc that was produced in Canada during 1988 was not replaced with new ore, and reserves were reduced at a number of mines as well.

Silver

Even though much of the silver mined during 1988 was not replaced with new-found ore, silver reserves were up 5% at the beginning of 1989 compared with the previous year. Updating of national totals on the basis of the latest published company data on the Vangorda and Grum deposits was the single largest contributor to this increase. Three new mines counted in national totals for the first time were also large contributors to this increase: the Samatosum mine owned by Minnova Inc. and Rea Gold Corporation, and the Premier mine owned by Westmin Resources, Pioneer Metals Corporation, and Canacord Resources Inc. (both in British Columbia), as well as the Caribou mine in New Brunswick.

Nickel

For most operations, only a very small portion of the nickel mined during 1988 appears to have been replaced with new-found ore. Apparent deletion from mine totals of some mineralized material previously counted as reserves, coupled with the fact that few mines showed any net increase in reserves, contributed to a decline in total Canadian reserves of nickel of about 5% from 1988 to 1989. Overall, nickel reserves in Canada are still substantially larger relative to production levels than are the reserves of the other base metals.

MINE INVESTMENT

Expenditures on exploration have received much publicity since 1983 when flow-through shares started to be used extensively to finance the search for new mineral deposits. It is not as widely known that investments made at mines to maintain production account for the largest portion, by far, of all investments made by the mineral industry in any given year.

Investments (including capital and repair expenditures) for all metal mines, non-metal mines, coal mines, sand pits and quarries (but excluding oil and gas) amounted to over $4 billion in 1988, almost 80% of the $5.4 billion spent in total at mines and on all exploration projects in Canada during that year. Exploration aimed at finding new deposits on producing properties would increase investments made at mine sites by only another $140 million, since almost 90% of all mineral exploration is conducted on properties that are not in production or that are not committed for production.

Investment by Type

Mine investments in Canada consist of: building new surface and underground structures; installing new or used machinery and equipment; outlining and preparing ore for production; and making repairs to existing structures, machinery and equipment.

Repairs to surface and underground structures, machinery and equipment have been consistently the largest of the four mine investment catagories during the 1980s. In 1988, repairs accounted for 42% of such investments; development of deposits for production held second place at 26%; new machinery and equipment and new construction held the balance at 19% and 13% respectively.

Compared with last year's revised estimates, mine investments (adjusted for inflation) in 1988 were up about 4% over those of 1987 and up some 11% over those of 1986, due to small annual increases in investments in structures and machinery. However, since 1981, annual mine investments (again in constant dollars) have declined by about 30% (Figure 2). During this decade, annual investments in repairs and development have remained essentially flat, while investments in machinery and equipment, as well as those in surface and underground structures, have generally declined each year falling, in 1988, to less than half of what they were in 1981.

Investment by Province and Territory

During 1988, almost 70% of investments to maintain production were made in Ontario, British Columbia and Quebec, by far the country's leading producers (in that order) of the mineral commodities under discussion (Figure 3).

Investment by Commodities

Almost 70% of the total investments made to maintain production in Canada during 1988 were made by metal producers. These producers together made larger expenditures in all four investment categories than all other producers.

Gold producers alone made close to 30% of the total mine investments in Canada in 1988, by far the largest of any single mineral commodity group. They also made the largest investments of any single mineral commodity group on development, new structures, machinery and equipment (Figure 4). Mine investments by gold producers in 1988 ($1.1 billion) were about equal to those made by base-metal producers. Since 1980, gold producers have, in real terms, increased mine investments fourfold, but investments by base-metal producers have been relatively flat since the mid-1980s. Investments by producers of non-metallic minerals have declined each year since the early 1980s.

Among producers of nonmetals, coal producers invested the most to maintain production and the most in repairs.

NEW PROJECTS ANNOUNCED DURING 1989

More than a dozen mining projects of widely differing scope were announced during 1989. This, however, was fewer than in 1988 when at least 29 such projects were recorded, and considerably less than in 1987 when 43 projects were recorded; the yearly average recorded since 1980 has been about 25. In 1989, more than half of the projects announced were for base metals. This represents a reversal of what took place in the past few years. In 1986 and 1987, precious metals, mainly gold, accounted for about 80% of project announcements. Since 1980, precious metals have, on average, accounted for 65% of new projects announced.

The total capital cost of new precious-metal and base-metal projects announced in the press during 1989 to bring on-stream additional capability for ore and concentrate production in Canada will amount to at least $688 million over the next few years (Table 5). For the third year in a row, the total value (corrected for inflation) of projects announced in the press has fallen, in line with the general declining trend since 1980. The value of gold projects announced during 1989 was less than 10% of the total value of projects announced. This represents a considerable departure from the high of over 70% in 1987 and the average of about 50% during the 1980s.

PROMISING DEPOSITS

The number of precious-metal and base-metal deposits in Canada judged promising for future production has grown each year from about 100 in 1983 to almost 270 at the end of 1989. From the end of 1988 to the end of 1989 alone, the number of promising deposits has increased by more than 150%. In December 1989, almost 30% of the precious-metal and base-metal deposits considered promising for future production were located in Quebec, and about 20% in each of British Columbia and Ontario.

Base-metal deposits now comprise over 20% of all promising deposits. This also represents a significant reversal of the trend that began in the early 1980s and which saw promising base-metal deposits gradually decline from almost 60% of all promising deposits to a little over 10% in 1988.

Currently promising Canadian base-metal deposits include: Windy Craggy, Cirque, Mt. Milligan, Kerr, J&L, Tulsequah Chief, and Mt. Polley in British Columbia; the Aur-Louvem discovery in Quebec; Lindsley in Ontario; McIlvenna Bay (Hanson Lake) in Saskatchewan; and Dy, Wellgreen and Logan in the Yukon.

OUTLOOK

There is still tremendous momentum in Canada aimed at proving up new gold reserves. Even though gold reserves have more than doubled since 1983, there are over 200 gold deposits currently being explored that appear particularly promising for future production. While work on these deposits amounts to only a fraction of current exploration efforts, these deposits alone represent a pool of gold in mineralized material that is potentially as large as current Canadian mine reserves of gold. Therefore, substantial additions to reserves of gold in Canadian orebodies are likely to continue for the foreseeable future.

Compared with the beginning of the 1980s, reserves of base metals are down by 20% to almost 60%, depending on the metal. However, from 1988 to 1989, the number of promising base-metal deposits has tripled to about 60. More than a dozen of these base-metal deposits each have potential mineral inventories valued at more than $1 billion at January 1990 metal prices. Many of these deposits have exploration programs backed by at least one major company, others by several such companies. Eventually, some of these deposits will be developed into large mines and contribute to the new reserves needed to maintain Canadian base-metal production in the coming years.[2]

REFERENCES

1 A. Lemieux, L.-S. Jen, D.A. Cranstone and G. Bouchard, "Canadian Mines: Perspective From 1989 - Production, Reserves, Development, Exploration," Energy, Mines and Resources Canada, Ottawa.

2 See, for example, Cranstone, Donald A., and Lemieux, André, "Base Metals - Today's Exploration Challenge", Congrès Annuel de l'Association des Prospecteurs du Québec, Val-d'Or, Quebec, September, 1988 (Updated March 8, 1989).

Note: Information contained in this review was current as at December 31, 1989.

TABLE 1: CANADIAN RESERVES, 1979-89

Metal	Units[2]	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989[4]
(Quantities of Metals Contained in Proven and Probable Mineable Ore[1] In Operating Mines and Deposits Committed for Production as at January 1st)												
Copper	000 t	15 840	16 405	16 831	15 815	17 022	16 163	15 788	14 384	13 331	12 986	12 693
Nickel	000 t	7 070	7 245	8 304	8 013	7 581	7 339	7 222	7 047	6 704	6 605	6 279
Lead	000 t	8 911	9 557	10 119	10 244	9 029	9 048	8 887	8 012	7 167	6 681	6 969
Zinc	000 t	26 452	28 635	29 436	29 505	26 077	26 371	26 218	23 747	22 423	20 741	21 116
Molybdenum	000 t	462	554	550	514	494	446	392	363	346	242	235
Silver	t	29 398	31 564	33 614	32 154	31 381	31 359	31 298	28 795	26 694	25 660	26 959
Gold[3]	t	410	540	770	842	838	1 167	1 205	1 358	1 496	1 748	1 914

[1] No allowance is made for losses in milling, smelting and refining. [2] One tonne = 1.1023113 short tons. One kilogram = 32.150746 troy ounces. [3] Excludes metal in placer deposits. [4] Includes metal in mines where production has been suspended indefinitely.

TABLE 2: CANADIAN RESERVES BY PROVINCE AND TERRITORY

Metal	Units[3]	Nfld.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	B.C.	Y.T.	N.W.T.	Canada[5]
(Quantities of Metals Contained in Proven and Probable Mineable Ore[1] In Operating Mines and Deposits Committed for Production as at January 1, 1989[2])												
Copper	000 t	-	34	302	838	5 866	515	5	5 133	-	-	12 693
Nickel	000 t	-	-	-	-	4 546	1 733	-	-	-	-	6 279
Lead	000 t	-	-	3 482	-	101	20	-	1 071	1 755	540	6 969
Zinc	000 t	36	60	8 575	836	3 265	1 016	2	2 270	2 816	2 239	21 116
Molybdenum	000 t	-	-	-	0	18	-	-	216	-	-	235
Silver	t	-	-	9 933	1 200	5 802	812	3	6 140	2 943	127	26 959
Gold[4]	kg	38 357	2 098	73 769	372 660	1 016 919	49 813	6 805	171 684	39 853	142 237	1 914 195

[1] No allowance is made for losses in milling, smelting and refining. [2] Includes metal in mines where production has been suspended indefinitely. [3] One tonne = 1.1023113 short tons. One kilogram = 32.150746 troy ounces. [4] Excludes metal in placer deposits. [5] May not balance due to rounding at the provincial level.
- Nil.

TABLE 3. NEW MINING OPERATIONS AND COMMITMENTS TO PRODUCTION WHOSE RESERVES WERE ADDED TO CANADIAN TOTALS AS AT JANUARY, 1989

Operation	Operators and Major Partners	Major Metals	Province/Territory
Tangiers[1]	Coxheath Gold Holdings Limited	gold	N.S.
Heath Steele-Stratmat	Brunswick Mining and Smelting Corporation Limited and Noranda Inc.	copper, lead, zinc, silver	N.B.
Caribou	East West Caribou Mining Limited	lead, zinc, silver, gold	N.B.
Beauchastel	Augmitto Explorations Limited	gold	Que.
Kierens	Aur Resources Inc.	gold	Que.
Sleeping Giant	Aurizon Mines Ltd.	gold	Que.
Lucien C. Beliveau[2]	Cambior inc.	gold	Que.
Beauchemin	Cambior inc.	gold	Que.
Manitou-Barvue (Tailings)	Gold Spinners Resources Inc.	gold	Que.
Perry[3]	Minnova Inc.	copper, silver, gold	Que.
Francoeur	Rouyn Mining Resources Inc. and LAC Minerals Ltd.	gold	Que.
No. 5 Shaft (Crown Pillar)	Falconbridge Limited	copper, nickel, silver gold	Ont.
Magino	Muscocho Explorations Ltd. and McNellen Resources, Inc.	gold	Ont.
Magnacon	Muscocho Explorations Ltd., Flanagan McAdam Resources Inc. and Windarra Minerals Ltd.	gold	Ont.
Louanna (Tailings)	Pelham Gold "N" Grain Inc. and Cumo Resources Ltd.	gold	Ont.
Chisel Lake North	Hudson Bay Mining and Smelting Co., Limited	copper, zinc, silver, gold	Man.
Callinan	Hudson Bay Mining and Smelting Co., Limited and Manitoba Mineral Resources Ltd.	copper, zinc, silver, gold	Man.
Jolu	Corona Corporation and International Mahogany Corp.	silver, gold	Sask.
Nickel Plate (Tailings)	Candorado Mines Ltd. and Cantrell Resources Ltd.	silver, gold	B.C.
Samatosum	Minnova Inc. and Rea Gold Corporation	copper, lead, zinc, silver, gold	B.C.
New Privateer	New Privateer Mine Limited	gold	B.C.
Pilot Bay (Stockpile)	Savoy Minerals Ltd.	lead, zinc, silver, gold	B.C.
Ajax	Teck Corporation	copper, silver, gold	B.C.
Premier	Westmin Resources Limited, Pioneer Metals Corporation, Canacord Resources Inc., and Tournigan Mining Explorations Ltd.	silver, gold	B.C.
Colomac	Neptune Resources Corp.	gold	N.W.T.

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[1] Production started in June 1988 and was suspended in June 1989. [2] Formerly Pascalis mine. [3] Closed November 1983. Reopened during 1988.

TABLE 4. CANADIAN RESERVES OF GOLD, JANUARY 1989: SOURCES AND RECOVERABILITY

Sources	Gold in Mineable Reserves		Expected Concentrator Recovery	Estimated Gold Recoverable in Concentrates	
	(tonnes)	(%)	(%)	(tonnes)	(%)
Conventional Gold Mines	1 453	76	93	1 356	85
By-product Gold (in base-metal deposits)	359	19	53	191	12
Tailings and Other Wastes	102	5	53	54	3
Total	1 914	100	84	1 601	100

Source: Energy, Mines and Resources Canada.

TABLE 5: MINING PROJECTS ANNOUNCED DURING 1989

Companies	Project	Metals	Start-up Year	Incremental Project Budget ($ million)
PRECIOUS METALS				
Noranda Exploration Company, Limited; Cambior inc.; Nova-Cogesco Resources Inc.	New 400 000 t/y Silidor underground mine, Rouyn-Noranda area, Quebec	Gold	1990	31.5
Inco Gold Company; Golden Knight Resources Inc	New 140 000 t/y Golden Pond West underground mine, Casa Berardi area, Quebec	Gold	1990	30.
Giant Yellowknife Mines Limited	Reactivation of 18 000 t/m Hoyle Mine, Timmins area, Ontario	Gold	1990 ?	3.0
Sphinx Exploration Inc. (Ariel Mining Group, The)	New 50 000 t Duvay-Obalski open-pit heap-leach mine, Amos area, Quebec	Gold	1989	1.1
Aurtec Mining Development Inc.	New 300 000 t Montauban heap-leach tailings reprocessing operation, Quebec area, Quebec	Gold, silver	1989	0.3
Goldpost Resources Inc.	New 9000 t Hislop West underground mine (Gibson West zone), Ontario	Gold	1989	n.a.
			Sub-total	65.9
BASE METALS AND BY-PRODUCTS				
Falconbridge Limited	Development of 1 million t/y Craig underground mine, Sudbury, Ontario	Nickel, copper, precious metals	1993	280.
Inco Limited	New 6350 t/d McCreedy East underground mine, Levack area, Ontario	Nickel, copper, precious metals	1993	179
Falconbridge Limited	Development of Kidd Creek No. 3 underground mine (4600-6800 level), Timmins, Ontario	Zinc, copper, lead, silver	1996	100.
Inco Limited	Development of Lower Coleman underground mine, (all-electric) Sudbury, Ontario	Nickel, copper, precious metals	1990	39.

TABLE 5. (cont'd)

Company	Project	Metal	Start-up Year	Incremental Project Budget ($ million)
Brunswick Mining and Smelting Corporation Limited; Noranda Inc.	Reactivation of the Heath-Steele underground/open-pit mine and 2200 t/d concentrator (Heath-Steele and Stratmat properties), Newcastle area, New Brunswick	Zinc, lead, copper, silver	1989	21.
Timmins Nickel Inc.; BHP-Utah Mines Ltd.	New 320 t/d Redstone underground mine, Timmins area, Ontario	Nickel	1989	4.
Inco Limited	Reactivation of 1800 t/d Shebandowan underground mine and concentrator, Shebandowan, Ontario	Nickel, copper, precious metals	1989	n.a.
Western Mining Corporation Holdings Limited	Reactivation of Gays River underground mine and concentrator, Gays River, Nova Scotia	Zinc, lead	1990	n.a.
			Sub-total	623.
			All Metals Total	688.9

Source: Energy, Mines and Resources Canada, based on press reports to the end of December 1989.
n.a. Not available.

TABLE 5

TONNAGE AND GRADE OF ADDITIONAL BASE-METAL AND PRECIOUS-METAL DEPOSITS CONSIDERED IN DECEMBER 1989 PROMISING FOR FUTURE PRODUCTION

- DEPOSITS: Individual deposits have been selected primarily on the basis of information on: (a) state of exploration and development, (b) tonnage and grade, and (c) other factors affecting viability. This list includes mostly deposits for which recent exploration and development activities have been publicly reported; it excludes deposits committed for production.
- TONNAGE and GRADE: As reported by companies or, where necessary, from the secondary source that appeared to be the most reliable. Imperial units reported were converted to metric units and rounded. Descriptions such as "probable and possible" are those reported by companies.
- COMPANIES: Where two or more companies are identified with a deposit, the first is usually the operator.

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)[2]	Au (g/t)[2]
NEWFOUNDLAND										
Cape Ray	Dolphin Explorations Ltd.	Potentially mineable and additional	424 000	-	-	-	-	-	-	10.3
Duck Pond-Tally Pond	Noranda Inc. BP Resources Canada Limited	Mineral inventory	4 000 000	3.53	-	1.05	6.62	-	67.5	0.93
Nugget Pond	Bitech Corporation	Drill indicated geological	513 744	-	-	-	-	-	-	14.13
Rambler - Main Mine	Teck Corporation Petromet Resources Limited Newfoundland Exploration Company Limited	Unmined reserves	157 000	1.75	-	-	1.09	-	38.4	13
Rambler - Ming Mine	Teck Corporation Petromet Resources Limited Newfoundland Exploration Company Limited	Pillars and unmined reserves	454 000	-	-	-	-	-	-	2
Rambler - Ming West	Teck Corporation Petromet Resources Limited Newfoundland Exploration Company Limited	Drill indicated geological	100 000	5.6	-	-	0.37	-	-	2.37
Rambler - Tailings	Teck Corporation Petromet Resources Limited Newfoundland Exploration Company Limited	Potentially mineable	1 163 671	0.31	-	-	-	-	-	1.68
NOVA SCOTIA										
Cochrane Hill	NovaGold Resources Incorporated	Geological proven, probable and possible	609 925	-	-	-	-	-	-	11
Egerton McLean	Petromet Resources Limited	Drill indicated probable	245 015	-	-	-	-	-	-	10.2
Goldboro	Exploration Orex Inc.	Probable	1 044 000	-	-	-	-	-	-	6.2
Goldenville	Murray Brook Resources Incorporated NovaGold Resources Incorporated	Potential	1 134 000	-	-	-	-	-	-	8.6
Leipsigate	Coxheath Gold Holdings Limited	Inferred	423 265	-	-	-	-	-	-	11.66
Lower Seal Harbour	Scotia Prime Minerals, Incorporated Lotus Resources Limited	Geological	247 306	-	-	-	-	-	-	4.1
Mooseland	Hecla Mining Company of Canada Ltd Acadia Mineral Ventures Limited	Inferred	414 400	-	-	-	-	-	-	16
Touquoy	Seabright Explorations Incorporated	Drill indicated probable	1 059 000	-	-	-	-	-	-	2.63

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)[2]	Au (g/t)[2]
NEW BRUNSWICK										
Captain North Extension	Stratabound Minerals Corp.	Open pit	191 000	-	-	2.98	7.6	-	100	-
Half Mile Lake - Down Plunge	Noranda Incorporated Conwest Exploration Company Limited	Geological	5 300 000	0.08		1.25	10.26	-	29	-
Mount Pleasant[3]	Novagold Resources Incorporated LAC Minerals Ltd. Billiton Metals Canada Inc.	Geological	5 897 000	-	-	-	-	-	-	-
Murray Brook Copper	NovaGold Resources Incorporated		298 000	4.68	-	-	-	-	-	-
Restigouche	Marshall Minerals Corp. East West Caribou Mining Limited	Open pit	1 043 000	0.38	-	5.96	7.71	-	124	1.4
QUEBEC										
Abior	Exploration Essor Inc. Black Cliff Mines Limited	Drill indicated	210 000	-	-	-	-	-		7.5
Arntfield - Zones 4 and 5	Noranda Inc. Nova-Cogesco Resources Inc.	Geological	759 936	-	-	-	-	-	-	4.1
Astoria	Belmoral Mines Ltd. Yorbeau Resources Inc.	Proven, probable and possible	1 271 503	-	-	-	-	-	-	6.14
Beaufort	Louvem Mines Inc. Aurizon Mines Ltd.	Proven, probable and possible	309 000	-	-	-	-	-		8.9
Clerno	McAdam Resources Inc.	Indicated and possible	221 852	-	-	-	-	-	-	3.77
Connell Corner - D Zone	Aurizon Mines Ltd. Ezekiel Explorations Ltd.		83 000	1.9	-	-	-	-	-	-
Connell Corner - E Zone	Aurizon Mines Ltd. Ezekiel Explorations Ltd.		140 000	1.7	-	-	-	-	-	-
Courvan (Cournor Beaufort)	Louvem Mines Inc. Courvan Mining Company Limited Aabarock Inc.	Probable	216 900	-	-	-	-	-	-	7.2
Courville	Explorations Cache Inc. Parquet Resources Inc. Finor Exploration Inc.	Probable	123 000	-	-	-	-	-	-	6.9
Cronor	Cambior inc. Dominion Explorers Inc.		386 000	-	-	-	-	-	-	5.48
Delta - D8 and D9 Zones	Oasis Resources Inc. Messeguay Mines Inc. Falconbridge Limited	Possible and potential	1 022 800	1.1	2.62	-	-	-	-	-
Donalda Mine - No. 1 and 2 Veins	Minnova Inc. Thunderwood Resources Inc.		729 000	-	-	-	-	-		8.6
Douay-Vezza	Inco Gold Company Societe d'Exploration Miniere Vior Inc. Cambior inc.		505 000	-		-	-	-	-	7.9
Dubuisson	Nova-Cogesco Resources Inc. Quebec Explorers Corporation Ltd.	Drill indicated	260 975	-	-	-	-	-	-	6.5

Dubuisson East	Malartic Hygrade Gold Mines (Canada) Ltd. Minefinders Corporation Ltd.		453 592	-	-	-	-	-	-	5.8
Duverny	St. Genevieve Resources Ltd. Amalgamated Eastern, Gallant, Silver Sceptre, Standard Ltd.	Proven, probable and possible	132 473	-	-	-	-	-	-	5.42
East Amphi (Darius Joint Venture)	Breakwater Resources Ltd. Bond Gold Canada Inc.	Mineral inventory	531 300	-	-	-	-	-	-	8.61
Eastmain	MSV Resources Inc.	Proven and probable geological	864 000	-	-	-	-	-	-	12
Elder Mine	Aunore Resources Inc. Nova Beaucage Mines Limited	Proven, probable and possible	1 315 000	-	-	-	-	-	-	5.03
Estrades	Breakwater Resources Ltd. Golden Group Explorations Inc. Golden Hope Resources Inc.	Mineable	941 000	0.96	-	0.92	10.69	-	183	5.60
Fayolle	Exploration Essor Inc. Kerr Addison Mines Limited Eldorado Resources Limited	Drill indicated	188 000	-	-	-	-	-	-	7.5
Flordin	Cambior inc. Bachelor Lake Gold Mines Inc.	Indicated	527 769	-	-	-	-	-	-	5.0
Fontana	Bay Resources and Services Inc. Stratmin Inc. Jilbey Industries Ltd. St. Genevieve Resources Ltd.	Probable and possible	878 295	-	-	-	-	-	-	5.66
Fourax II	Bay Resources and Services Inc. Augmitto Explorations Limited	Possible	388 000	-	-	-	-	-	-	3.5
Gand	Algonquin Minerals Inc. Greenstone Resources Ltd.	Drill indicated	104 000	-	-	-	-	-	-	4.97
Golden Pond - Main Zone	Inco Gold Company Golden Knight Resources Inc.		4 191 000	-	-	-	-	-	-	7.9
Goldex	Goldex Mines Limited	Proven diluted	778 229	-	-	-	-	-	-	2.5
Goldstack - New Discovery	Sphinx Exploration Inc. Goldstack Resources Ltd.	Probable and possible	658 163	-	-	-	-	-	-	5.97
Goldstack Mine - Residual Tonnage	Sphinx Exploration Inc. Goldstack Resources Ltd.	Possible	454 000	-	-	-	-	-	-	6.5
Grevet "B"	VSM Exploration Inc. Serem Quebec Inc.		504 000	0.59	-	-	9.37	-	22.2	-
Grevet "M"	VSM Exploration Inc. Serem Quebec Inc.	Probable and possible	5 648 700	0.47	-	0.17	8.59	-	34.98	0.154
Gwillim Lake - Mop II	Muscocho Explorations Ltd. Flanagan McAdam Resources Inc. Noranda Inc.	Drill indicated	205 700	-	-	-	-	-	-	11
Gwillim Mine	Flanagan McAdam Resources Inc. Greenstone Resources Ltd.	Preliminary	306 800	-	-	-	-	-	-	10
Hebecourt	Deak International Resources Holdings Ltd. Noranda Inc.		717 000	2.7	-	-	-	-	-	-
Howfran - East	Aur Resources Inc. Bachelor Lake Gold Mines Inc.	Proven and probable	131 000	-	-	-	-	-	-	6.2
Howfran - West	Aur Resources Inc. Bachelor Lake Gold Mines Inc.	Drill indicated	363 000	-	-	-	-	-	-	6.2

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)^1	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)^2	Au (g/t)^2
QUEBEC (cont'd)										
Inmont	Vior Inc Teck Corporation Mazarin Mining Exploration Inc		113 000	1.6	-		-	-	-	1.0
John	Concorde Exploration Ltd		210 000							6.00
Joubi	Western Quebec Mines Inc Messeguay Mines Inc Oasis Resources Inc		541 370							5.82
Lac Fortune	Rouyn Mining Resources Inc	Proven, probable and possible	234 050							5.37
Lamaque Mine - All Zones	Tundra Gold Mines Limited Golden Pond Resources Ltd A-PRI-OR Mining Exploration Inc Teck Corporation	Drill indicated, proven, probable and possible	1 574 000							6.72
Launay Privat - Zone 75	Corona Corporation Messaguay Mines Inc	Probable and possible	491 000							4.1
Louvicourt - Aur Louvem Discovery	Aur Resources Inc Louvem Mines Inc Teck Corporation Cominco Ltd		32 659 000	3.11	-	-	1.34	-	19	0.86
Magusi	Deak International Resources Holdings Ltd Noranda Inc		1 270 000		-	-	6.54	-	32	1.9
Manitou Barvue - Tailings	Gold Spinners Resources Inc St. Genevieve Resources Ltd Louvem Mines Inc		6 169 000	0.07	-	0.07	0.36	-	12	0.7
McWatters Mine	McAdam Resources Inc	Preliminary	826 326							6.5
Monique	Monique Exploration Inc Louvem Mines Inc	Probable and possible	907 000							6.2
Mouska	Cambior Inc	Mining reserves	1 635 000							6.2
Norlartic Mine	Aur Resources Inc Nova-Cogesco Resources Inc		996 000							4.8
Normetal Mine	La Sarre Mining Exploration Inc Exploration Miniere Normetal Inc	Probable and possible	392 599	-	-	-	11.72	-	36.24	-
Noyon - RJ Zone	Northway Explorations Limited	Preliminary	304 580							5.5
Obalski Mine	Thunderwood Resources Inc Greenstone Resources Ltd		172 000	1.7						3.8
O'Brien - 36E Zone	Breakwater Resources Ltd	Drill indicated possible	249 740							8.2
Orenada - Zone 4	Aur Resources Inc	Geological	3 629 000							1.7
Pandora	American Barrick Resources Corporation	Drill indicated geological	2 114 000							4.5
Parbec	St. Genevieve Resources Ltd Augmitto Explorations Limited	Possible	413 000							4.63
Pelletier Lake	Falconbridge Limited Thunderwood Resources Inc	Drill indicated	883 000							6.9

Philibert	Societe quebecoise d'exploration miniere (SOQUEM) Cambior inc.	Inventory	525 000	-		-			-	6.13
Poirier Mine - Copper	Ressources Miniere Forbex Inc. Bonanza Metals Inc.	Proven and probable	514 750	2.45	-	-	-	-	-	-
Poirier Mine - Zinc	Ressources Miniere Forbex Inc. Bonanza Metals Inc.	Proven and probable	585 701	-	-	-	10.61	-	-	-
R M Nickel[4]	Equinox Resources Ltd. Technigen Corporation Minnova Inc.	Mineable open pit	132 000	0.7	0.46		-	-	-	-
Simkar Mine	Ronrico Explorations Ltd. Louvicourt Gold Mines Inc.	Proven, probable and possible	208 954	-	-	-	-	-	-	8.18
Simon Ouest	Louvem Mines Inc. Monique Exploration Inc.	Probable	100 800	-	-	-	-	-	-	6.58
Stadacona Mine - East (Forbex)	Cambior inc. Ressources Minière Forbex Inc.		499 000	-	-	-	-	-	-	5.8
Tache - Main Zone	Greenstone Resources Ltd. Bitech Corporation	Probable and possible	1 399 000	-	-	-	3.3	-	-	1.9
Tiblemont	Maufort Resources Inc.	Drill indicated	79 000	-	-	-	-	-	-	5.8
Vassan	Vassan Resources Inc.	Probable	44 000	-	-	-	-	-	-	6.5
Vendome - Main Deposit	Abcourt Mines Inc. Val d'Or Resources Inc.		544 000	0.45	-	0.31	7.4	-	52	1.
Vezza Twp.	Agnico-Eagle Mines Limited Dundee-Palliser Resources Inc. North American Rare Metals Limited	Probable and possible	1 814 000	-	-	-	-	-	-	5.66
Warrenmac	LAC Minerals Ltd. Cambior inc.	Mineral inventory	170 000	-	-	-	3.2	-	27	6.9
Wasamac Mine	Rouyn Mining Resources Inc. LAC Minerals Ltd.	Probable, drill indicated and possible	1 759 451	-	-	-	-	-	-	4.73
West MacDonald	Deak International Resources Holdings Ltd Noranda Inc. MacDonald Mines Exploration Ltd.	Open pit and underground	1 043 000	-	-	-	6.84	-	29	0.823
Westwood	LAC Minerals Ltd. Cambior inc.	Mineral inventory	417 000	-	-	-	-	-	-	9.3
ONTARIO										
Anoki	Queenston Mining Inc. Inco Gold Company		544 000	-	-	-	-	-	-	4.8
Armistice - Kerr and Sheldon	Armistice Resources Ltd.	Drill indicated and possible	502 000	-	-	-	-	-	-	5.1
Arseno Lake	Northern Dynasty Explorations Ltd.	Drill indicated	907 000	-	-	4.4	4.4	-	51	-
Bankfield and Tombill Tailings	Roxmark Mines Limited Ateba Mines Inc.	Processible	363 000	-	-	-	-	-	-	1.4
Bannockburn	Micham Exploration Inc. Mono Gold Mines Inc.	Modified geological	170 000	-	-	-	-	-	-	7.68
Bateman	McFinley Red Lake Mines Limited Sabina Resources Limited	Geologically inferred	807 000	-	-	-	-	-	-	7.2

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)[2]	Au (g/t)[2]
ONTARIO (cont'd)										
Bristol - Main Zone	Chevron Minerals Ltd Holmer Gold Mines Limited		400 000	-	-	-	-	-	-	5.1
Brookbank	Placer Dome Inc. Metalore Resources Limited		1 179 000	-	-	-	-	-	-	10
Cadieux	Breakwater Resources Ltd Cameco - A Canadian Mining & Energy Corporation	Probable and possible	904 799	-	-	0.87	9.61	-	-	-
Cameron Lake	Nuinsco Resources Limited	Proven, probable and possible	2 866 838	-	-	-	-	-	-	5.76
Cedar Island	Bond Gold Canada Inc. Kenora Prospectors & Miners, Limited		1 271 692	-	-	-	-	-	-	8.6
Chester Twp.	Chesbar Resources, Inc. Murgold Resources, Inc.	Proven, probable and possible	384 234	-	-	-	-	-	-	7.64
Clavos	Bruneau Mining Corporation Canamax Resources Inc.	Drill indicated	1 052 000	-	-	-	-	-	-	5.1
Cochenour - Chert	Inco Gold Company Wilanour Resources Limited Pronto Explorations Limited	Potential	567 000	-	-	-	-	-	-	7.2
Cordova Mine	Mill City Gold Mining Corp. Gunnar Gold Mining Corp. Lasir Gold Industries Inc.		200 000	-	-	-	-	-	-	6.2
De Santis Mine	Golden Terrace Resources Corporation Stan West Mining Corp.	Probable and possible	303 279	-	-	-	-	-	-	6.5
Duport	Consolidated Professor Mines Limited	Proven, probable, possible and inferred	1 785 700	-	-	-	-	-	-	12
Eagle River	Hemlo Gold Mines Inc. Central Crude Ltd.	Drill indicated	1 606 000	-	-	-	-	-	-	8.6
Edwards Mine	Spirit Lake Explorations Limited	Drill indicated	172 626	-	-	-	-	-	-	12
Favourable Lake - No. 3 Vein	Echo Bay Mines Ltd Zahavy Mines Limited	Mineral inventory	180 617	-	-	-	-	-	175	7.71
Fuller	Vedron Limited		345 000	-	-	-	-	-	-	5.5
Gaffney	Teck Corporation		272 000	-	-	-	-	-	-	5.1
Garrcon	Jonpol Explorations Limited LAC Minerals Ltd	Drill indicated	318 300	-	-	-	-	-	-	6.5
Garrison Twp	LAC Minerals Ltd Perrex Resources Inc Silverside Resources Ltd	Drill indicated	544 000	-	-	-	-	-	-	6.2
Garrison Twp	Jonpol Explorations Limited T & H Resources Ltd LAC Minerals Ltd	Drill indicated	1 188 000	-	-	-	-	-	-	7.92

Goldlund Mine	Camreco Inc	Proven and probable	708 000	-	-	-	-	-	-	4.7
Goudreau River	Ego Resources Limited	Drill indicated	318 000	1.62	-	-	-	-	-	3.91
Gracie and St. Joseph	LAC Minerals Ltd Queenston Mining Inc	Proven and possible	306 084	-	-	-	-	-	-	22
Greater Lenora	American Barrick Resources Corporation Greater Lenora Resources Corp	Possible and potential	476 000	-	-	-	-	-	-	4.42
Hislop - East	Goldpost Resources Inc New Kelore Mines Limited	Drill indicated and possible	758 000	-	-	-	-	-	-	5.8
Hislop - West	Mining Corporation of Canada Limited	Drill indicated	17 445	-	-	-	-	-	-	20
Hislop - Creek Zone	Stroud Resources Ltd Chevron Minerals Ltd	Drill proven and drill indicated	681 000	-	-	-	-	-	-	6.45
Hislop - Main Zone	Stroud Resources Ltd. Chevron Minerals Ltd	Drill proven and drill indicated	93 000	-	-	-	-	-	-	5.83
Hislop - Matachewan	Noranda Inc. Alban Explorations Ltd. Matachewan Consolidated Mines, Limited		181 000	-	-	-	-	-	-	3.1
Horseshoe Island	Noranda Inc Noront Resources Ltd		771 000	-	-	-	-	-	-	4.63
Iris	LAC Minerals Ltd Perrex Resources Inc		1 089 000	-	-	-	-	-	-	2
Jerome Mine	Muscocho Explorations Ltd. Jerome Gold Mines Corporation Chesbar Resources Inc McNellen Resources, Inc		544 000	-	-	-	-	-	-	6.9
Kanichee Mine	Northern Platinum Ltd		1 143 550	0.48	0.31	-	-	-	-	-
Kirkland Lake - Tailings	Eastmaque Gold Mines Ltd Teck Corporation		227 000	-	-	-	-	-	-	1.89
Kirkland Lake - Tailings	ERG Resources Inc Jimberlana Holdings (Canada) Corp		32 000 000	-	-	-	-	-	-	0.54
Larder Lake - Cheminis Carbonate	Golden Shield Resources Ltd Rockford Minerals Inc Northfield Minerals Inc	Possible	907 000	-	-	-	-	-	-	5.82
Larder Lake - Cheminis Mine	Golden Shield Resources Ltd Rockford Minerals Inc Northfield Minerals Inc	Drill indicated	2 495 000	-	-	-	-	-	-	5.49
Larder Lake - Fernland Mine	Golden Shield Resources Ltd Rockford Minerals Inc Northfield Minerals Inc	Drill indicated	41 000	-	-	-	-	-	-	5.82
Leckie	Stroud Resources Ltd. Lacana Ex (1981) Inc		175 000	-	-	-	-	-	-	7.37
Lindsley[5]	Falconbridge Limited		6 350 000	1.5	1.6	-	-	-	-	-
Lingman Lake	Agassiz Resources Ltd Twin Gold Mines Ltd		1 225 900	-	-	-	-	-	-	7.2
Lochalsh	Canamax Resources Inc.		1 377 000	-	-	-	-	-	-	6.6

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)[2]	Au (g/t)[2]
ONTARIO (cont'd)										
Marathon[6]	Fleck Resources Ltd. Euralba (Canada) Mining Ltd.		27 000 000	0 45	-	-	-	-	-	-
Maude Lake	Equinox Resources Ltd. Technigen Corporation Maude Lake Gold Mines Limited	Proven	118 000	-	-	-	-	-	-	5 42
Mishi	Granges Inc MacMillan Gold Corp	Geological	1 194 000	-	-	-	-	-	-	5 7
Moss Twp - Main Zone	Stormin Exploration Limited Tandem Resources Ltd		227 000	-	-	-	-	-	-	5 8
Nickel Offsets Mine	Noranda Inc Golden Princess Mining Corporation		544 000	-	-	-	-	-	-	7 9
Nighthawk Lake	Pamorex Minerals Inc		1 442 000	-	-	-	-	-	-	5 8
Purdex - P and B Zones	Consolidated Jaina Resources Limited		236 000	-	-	-	-	-	-	8 6
Richardson Lake	Golden Terrace Resources Corporation	Probable	91 000	-	-	-	-	-	-	7
Ronnoco	Trader Resource Corp. Ronnoco Gold Mines, Limited	Drill indicated	2 259 000		-	-	-	-	-	4 01
Swayze	Orofino Resources Limited	Mineable	577 000	-	-	-	-	-	-	6 3
Tully	Intex Mining Company Limited Frankfield Explorations Ltd.		272 000	-	-	-	-	-	-	7 5
Worvest	American Barrick Resources Corporation Greater Lenora Resources Corp.		735 117	-	-	-	-	-	-	5 14
MANITOBA										
Big Island Lake	Westfield Minerals Limited Goldbrae Developments Ltd	Potential mineralization	91 000	2	-	-	15	-	69	3
Burnt Timber	LynnGold Resources Inc. Trans-America Industries Ltd.	Geological	1 203 000	-	-	-	-	-	-	3 77
Dot Lake (K1-K4, K6)	LynnGold Resources Inc	Geological	703 000	-	-	-	-	-	-	3 4
Farley Lake - Gold	Mingold Resources Inc. Manitoba Mineral Resources Ltd		1 297 000	-	-	-	-	-	-	7 03
Ferro Mine	Pierce Mountain Resources Ltd Placer Dome Inc.		129 570	-	-	-	-	-	-	13 8
Island Lake Mine	Wydmar Development Corporation Bighorn Development Corporation	Proven, probable and drill indicated	387 000	-	-	-	-	-	-	10
Lasthope	Preston Resource Corp. Consolidated Jaina Resources Limited	Proven, probable and possible	805 600	-	-	-	-	-	-	10 4
Minago	Black Hawk Mining Inc	Drill indicated	3 629 000	-	1 28	-	-	-	-	-

Ore Fault	Milestone Resources Ltd.		272 000	0.4	0.5	-	0.28	-	171.	-
Pine Bay	Golden Terrace Resources Corporation Granges Inc.		1 100 000	2.76	-	-	-	-	-	-
Rainbow	LynnGold Resources Inc.		875 000	-	-	-	-	-	-	7.5
San Antonio Mine	Rea Gold Corporation	Proven and probable	1 361 000	-	-	-	-	-	-	7.61
Sannorm	Bakra Resources Ltd.		181 000	-	-	-	-	-	-	4.18
Snow Lake Mine	Inco Gold Company High River Gold Mines Ltd.		3 810 000	-	-	-	-	-	-	6.5
Snow Lake - No. 3 and Birch Zones	BHP-Utah Mines Ltd. Snow Lake Mines Ltd.		732 000	-	-	-	-	-	-	9.12
SASKATCHEWAN										
Athona	RJK Mineral Corp. Greater Lenora Resources Corp. Cominco Ltd.	Probable and possible	5 000 000	-	-	-	-	-	-	2.2
Batty Graham	Cameco - A Canadian Mining & Energy Corporation Vista Mines Inc.	Proven and probable	49 000	-	-	-	-	-	-	9.6
Box Mine	RJK Mineral Corp. Greater Lenora Resources Corp. Cominco Ltd.	Probable and possible	12 400 000	-	-	-	-	-	-	1.8
Brabant Lake	Gansan Resources Ltd.		3 695 381	0.55	-	0.27	4.84	-	18.63	0.18
Jasper Pond	Cameco - A Canadian Mining & Energy Corporation Shore Gold Fund Inc.	Geological	318 000	-	-	-	-	-	-	17.
Jojay	Cameco - A Canadian Mining & Energy Corporation Claude Resources Inc. Shore Gold Fund Inc.	Probable	295 000	-	-	-	-	-	-	7.47
Komis	Placer Dome Inc. Waddy Lake Resources Inc.	Drill indicated	1 100 000	-	-	-	-	-	-	3.8
Laurel Lake	Cameco - A Canadian Mining & Energy Corporation Husky Oil Ltd.	Probable geological	387 000	-	-	-	-	-	-	11.3
McIlvena Bay (Hanson Lake)	Cameco - A Canadian Mining & Energy Corporation Trimin Resources Inc.	Geological probable and possible	10 614 000	1.05	-	0.39	5.38	-	24	0.5
North Lake	Radcliffe Resources Ltd.	Geological	2 359 000	-	-	-	-	-	-	2.4
Preview Lake - Bakos Zone	Cameco - A Canadian Mining & Energy Corporation Uranerz Exploration and Mining Limited Windarra Minerals Ltd.	Probable and possible	1 297 000	-	-	-	-	-	-	10.
Preview Lake - Pap SW Zone	Cameco - A Canadian Mining & Energy Corporation Uranerz Exploration and Mining Limited Windarra Minerals Ltd.	Probable and possible	493 700	-	-	-	-	-	-	12.

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE						
				Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g t)[2]	Au (g t)[2]
SASKATCHEWAN (cont'd)										
Seabee	Claude Resources Inc.	Proven, probable, possible and inferred	1 825 000	-	-	-	-	-		12 5
Tower Lake - East	Golden Rule Resources Ltd Goldsil Resources Ltd Cameco - A Canadian Mining & Energy Corporation		2 041 000		-	-	-	-	-	3 3
Weedy Lake - B Zone	Tyler Resources Inc. Golden Rule Resources Ltd Cameco - A Canadian Mining & Energy Corporation		363 000	-	-	-	-	-	-	4 8
Weedy Lake - Golden Heart	Tyler Resources Inc. Golden Rule Resources Ltd Cameco - A Canadian Mining & Energy Corporation	Drill indicated	665 700	-	-	-	-	-	-	8 74
BRITISH COLUMBIA										
Abbott Wagner - Abbott Zone	Mikado Resources Ltd. Golden Arch Resources Ltd.		36 998	-	-	10 92	12 55	-	297	1 2
Adams Lake	Rea Gold Corporation	Drill indicated	241 500	0 5	-	2 2	2 2	-	73 4	6 5
Addington Mine	Cathedral Gold Corporation	Proven and probable geological	712 600	-	-	-	-	-	-	4 5
Alpine Mine - Stockpile	Cove Resources Corporation		23 000	-	-	-	-	-	-	14
Alpine Mine - Underground	Cove Resources Corporation		907 000	-	-	-	-	-	-	17
Ashlu Mine	Valentine Gold Corporation Tenquille Resources Ltd.	Proven and possible	91 000	-	-	-	-	-	-	8 6
Bralorne	Corona Corporation Imperial Metals Corporation	Proven, probable and possible	965 000	-	-	-	-	-	-	9 2
Canty	Golden North Resource Corporation	Drill indicated geological	595 800	-	-	-	-	-	-	5 28
Central Zeballos Mine	Canalaska Resources Ltd Consolidated Impact Resources Inc.	Proven and probable	68 000	-	-	-	-	-	-	12
Chappelle	Multinational Resources Inc.	Drill indicated	45 000						175	19
Chu Chua	Minnova Inc Pacific Cassiar Limited International Vestor Resources Ltd. Quinterra Resources Inc.		1 043 000	2 97		-		-	100 ●	0 6●
Cinola	City Resources (Canada) Limited Barrack Mines Limited	Mineable	23 800 000	-	-					2 43
Cirque	Curragh Resources Inc Hillsborough Resources Limited		30 000 000	-	-	2 2	7 8	-	48	
Congress	Levon Resources Ltd. Veronex Resources Ltd.	Geological	608 000	-						8 23
Debbie and Yellow	Westmin Resources Limited Nexus Resources Corporation	Probable	243 000	-	-		-	-	-	5 1

Dolly Varden - North Star Mine	Dolly Varden Minerals Inc.	Geological proven and probable	128 436	-	-	-	-	-	401 5	
Dome Mountain	Teeshin Resources Ltd. Canadian United Minerals Inc. TOTAL Energold Corporation		272 000	-	-	-	-	-	80 2	12 2
Dove Ingrid	Redbird Gold Corp	Possible	79 000	0 17	-	-	-	-	10.	1
Eskay Creek	Calpine Resources Incorporated Stikine Resources Ltd.	Geological	2 540 000	-	-	-	-	-	115.	7.9
Fireweed - West Zone	Canadian United Minerals Inc. Gunnar Gold Mining Corp.	Geological	581 000	-	-	1.34	2.22	-	342.	-
Giant Copper - AM Breccia	Bethlehem Resources Corporation	Open pit	20 684 000	0.75	-	-	-	-	12.	0.411
Goldfinch (Windflower)	Granges Inc. Windflower Mining Ltd.	Proven and probable	181 000	-	-	-	-	-	-	10.
Goldwedge	Catear Resources Ltd.	Drill indicated inferred	338 583	-	-	-	-	-	38.	26.
Harrison - Jenner Stock	Bema Gold Corporation Abo Resource Corp.	Drill indicated	2 204 000	-	-	-	-	-	-	4.1
Hedley	Noranda Inc. Banbury Gold Mines Ltd.		3 789 000	-	-	-	-	-		2.1
J&L	Placer Dome Inc. Equinox Resources Ltd. Pan American Minerals Corp.	Geological	13 100 000	-	-	2.6	5.4	-	69.	7.
Kamad 7	Homestake Mining (Canada) Limited Kamad Silver Co. Ltd.		220 000	0 54	-	6.19	7.32	-	69.19	7 36
Kerr	Placer Dome Inc. Sulphurets Gold Corporation	Potential	120 000 000	0.79	-	-	-	-	2.4	0.31
Lara	Minnova Inc. Laramide Resources Ltd.		529 000	1.01	-	1.22	5.87	-	100.	4.73
Midway	Regional Resources Ltd. Procan Exploration Company Limited	Geological	1 185 000	-	-	7.0	9.6	-	410.	-
Millie Mack	Greenstone Resources Ltd. Dragoon Resources Ltd.		18 144 000	-	-	-	-	-	154.	3.
Mt Milligan - Main	Continental Gold Corp. BP Resources Canada Limited	Mineral reserve	181 000 000	0.3	-	-	-	-	-	0.7
Mt Polley	Corona Corporation Imperial Metals Corporation	Mineable	48 081 000	0.44	-	-	-	-	-	0.58
Mt Washington - Lakeview Domineer	Better Resources Ltd.	Drill indicated	550 300	-	-	-	-	-	32.	6.75
North Texada - Yew Exclusion	Rhyolite Resources Inc. Echo Bay Mines Ltd.	Probable and possible	71 000	1.2	-	-	-	-	-	12.
Nugget Mine	Gunsteel Resources Incorporated Nugget Mines Ltd.		202 000	-	-	-	-	-	-	11
Polaris - Taku Mine	Suntac Minerals Corporation Rembrandt Gold Mines Ltd.	Potential	1 315 000	-	-	-	-	-	-	13.
Porcher Island Mine - AT Zone	Cathedral Gold Corporation		1 361 000	-	-	-	-	-	-	6.9

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)[2]	Au (g/t)[2]
BRITISH COLUMBIA (cont'd)										
QR - Main Zone	QPX Minerals Inc. Placer Dome Inc.		738 000	-	-	-	-	-	-	4.5
QR - West Zone	QPX Minerals Inc. Placer Dome Inc.		138 000	-	-	-	-	-	-	8.9
Redbird	Golden Eye Minerals Ltd. Hecla Mining Company of Canada Ltd.	Geological	900 000	-	-	-	8	-	69	-
Reliance - Imperial	Menika Mining Ltd.	Proven and indicated	412 000	-	-	-	-	-	-	5.97
Rossland - North Belt East	Antelope Resources Inc. Bryndon Ventures Inc.	Drill indicated inventory	47 001	-	-	-	-	-	-	7.9
Rossland - North Belt West	Antelope Resources Inc. Bryndon Ventures Inc.	Drill Indicated Inventory	16 864	-	-	-	-	-	-	16.
Rossland - South Belt	Antelope Resources Inc. Bryndon Ventures Inc.	Drill indicated inventory	34 633	-	-	-	-	-	-	19
SB	Westmin Resources Limited Tenajon Resources Corp.	Probable and possible geological	279 000	-	-	-	-	-	36.7	17.3
Silver Pond	Bond Gold Canada Inc. Nexus Resource Corporation		64 000	-	-	-	-	-	-	5.8
Silver Queen Mine	Pacific Houston Resources, Inc.	Proven, probable and indicated	1 726 000	-	-	-	6.19	-	328	2.7
Snip	Cominco Ltd. Prime Resources Corporation	Indicated and inferred	936 000	-	-	-	-	-	-	30.0
Snowbird - North Zone	X-Cal Resources Ltd.	Possible	227 000	-	-	-	-	-	-	6.9
Spud Valley Mine	McAdam Resources Inc.	Proven, probable and possible	220 450	-	-	-	-	-	-	10.8
Sulphurets	Newhawk Gold Mines Ltd. Granduc Mines Limited	Measured, indicated and inferred geological	726 000	-	-	-	-	-	786.5	12.1
Takla Rainbow	Takla Gold Mines Ltd. Reymont Gold Mines Ltd. Cathedral Gold Corporation	Drill indicated, inferred and potential	291 000	-	-	-	-	-	-	8.4
Tillicum Mtn - East Ridge Zone	Welcome North Mines Ltd. Esperanza Explorations Ltd.		372 000	-	-	-	-	-	-	11
Tillicum Mtn - Heino Money Zone	Welcome North Mines Ltd. Esperanza Explorations Ltd.		50 000		-	-	-	-	-	36.1
Toodoggone	Cheni Gold Mines Inc.	Geological	1 724 000	-	-	-	-	-	-	5.5
Treasure Mountain	Huldra Silver Inc.	Proven and probable	146 000	-	-	4.9[illegible]	4.9[illegible]	-	878	-
Tulsequah Chief Mine	Cominco Ltd. Redfern Resources Ltd.	Geological	5 262 000	1.6	-	1.31	7.03	-	100	2.7
Valentine Mountain - C Vein	Beau Pre Explorations Ltd.	Drill indicated	30 658	-	-	-	-	-	-	14.7

Vault	Inco Limited Seven Mile High Group Inc	Mineral resource	150 000	-	-	-	-	-	-	14
Windy Craggy[7]	Geddes Resources Limited Northgate Exploration Limited	Probable and possible	154 500 000	1.73	-	-	-	-	3.84	0.21
YUKON TERRITORY										
Barb - Matt Zone	Pulse Resources Ltd. Barytex Resources Corp.		533 000	-	-	6.1	4.6	-	103.	-
Dy (Underground)	Curragh Resources Inc.	Geological	21 100 000	-	-	5.5	6.7	-	84.	0.95
Grew Creek	Goldnev Resources Inc.	Geological inventory	773 000	-	-	-	-	-	34.	8.91
Hart Silver	Silver Hart Mines Ltd.		105 000	-	-	-	-	-	1934.	-
Logan	TOTAL Energold Cororation Fairfield Minerals Ltd.	Mineral reserve	12 338 000	-	-	-	6.17	-	26.	-
Marg	NDU Resources Ltd. Cameco - A Canadian Mining & Energy Corporation	Indicated and inferred	3 480 540	1.76	-	2.68	5.01	-	65.8	1.17
Mel	Barytex Resources Corp. Breakwater Resources Ltd.	Drill indicated	4 990 000	-	-	1.9	6.63	-	-	-
Mount Hundere - Jewel Box Hill	Curragh Resources Inc. Hillsborough Resources Limited		2 780 000	-	-	8.9	13.9	-	80.2	-
Mount Hundere - North Hill	Curragh Resources Inc. Hillsborough Resources Limited		2 440 000	-	-	1.1	12.6	-	45.	-
Mount Nansen	B.Y.G. Natural Resources Inc.	Proven, probable and possible	953 000	-	-	-	-	-	189.	9.3
Skukum Creek	Placer Dome Inc. Skukum Gold Inc. Omni Resources Inc.	Geological	800 000	-	-	-	-	-	275.	7.58
Wellgreen[4]	All-North Resources Ltd.	Probable and possible	49 695 000	0.35	0.36	-	-	-	-	-
NORTHWEST TERRITORIES										
Akaitcho and GPK	Supercrest Mines Limited Giant Yellowknife Mines Limited Akaitcho Yellowknife Gold Mines Limited	Proven and probable	127 438	-	-	-	-	-	-	12.8
Bugow - Andrew	Aber Resources Ltd.		64 000	-	-	-	-	-	-	5.5
Bugow - Cabin Creek	Aber Resources Ltd.	Drill indicated	91 000	-	-	-	-	-	-	10.
Coronation Gulf	Orofino Resources Limited Canuc Resources Inc.	Geological indicated	780 000	-	-	-	-	-	-	7.5
Crestaurum	Treminco Resources Ltd. Giant Yellowknife Mines Limited	Drill Indicated	290 000	-	-	-	-	-	-	7.5
Gab Tinker	Treminco Resources Ltd.	Drill indicated	27 000	-	-	-	-	-	-	11.
George Lake (Several Deposits)	Homestake Mining Company Kerr-McGee Corporation	Geological	2 000 000	-	-	-	-	-	-	10.
Nicholas Lake	Athabasca Gold Resources Ltd. Chevron Minerals Ltd.	Drill indicated and inferred	1 114 000	-	-	-	-	-	-	12.2

TABLE 6. (cont'd)

DEPOSITS	COMPANIES	TONNAGE AND GRADE DESCRIPTION	TONNAGE (tonnes)[1]	GRADE Cu (%)	Ni (%)	Pb (%)	Zn (%)	Mo (%)	Ag (g/t)[2]	Au (g/t)[2]
NORTHWEST TERRITORIES (cont'd)										
Ron	Cominco Ltd. Westview Resources Inc.	Potential	2 268 000	-	-	-	-	-	-	9.9
Southern - Cache	Noble Peak Resources Ltd.	Probable and possible	363 000	-	-	-	-	-	-	9.4
Sunrise Lake	Noranda Inc. Aber Resources Ltd. Hemisphere Development Corp.	Probable and possible	1 869 000		-	4.2	8.9	-	405	1.0
Tundra	Noranda Inc. TOTAL Energold Corporation Hemlo Gold Mines Inc.	Potential in situ	29 484 000			-	-	-	-	6.9

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[1] One tonne = 1.1023113 short tons. [2] One gram per tonne (g/t) = 0.02916668 troy ounces per short ton. [3] Tonnage reported grades 0.79% tin. [4] Also contains platinum and palladium. [5] Also contains cobalt, gold, silver, platinum and palladium. [6] Also contains nickel, platinum, palladium and gold. [7] Tonnage reported grades 0.09% cobalt.
- Nil; • Author's estimate.

Figure 1

DISTRIBUTION OF NET CHANGES IN GOLD RESERVES, 1988

ALL CANADIAN MINES

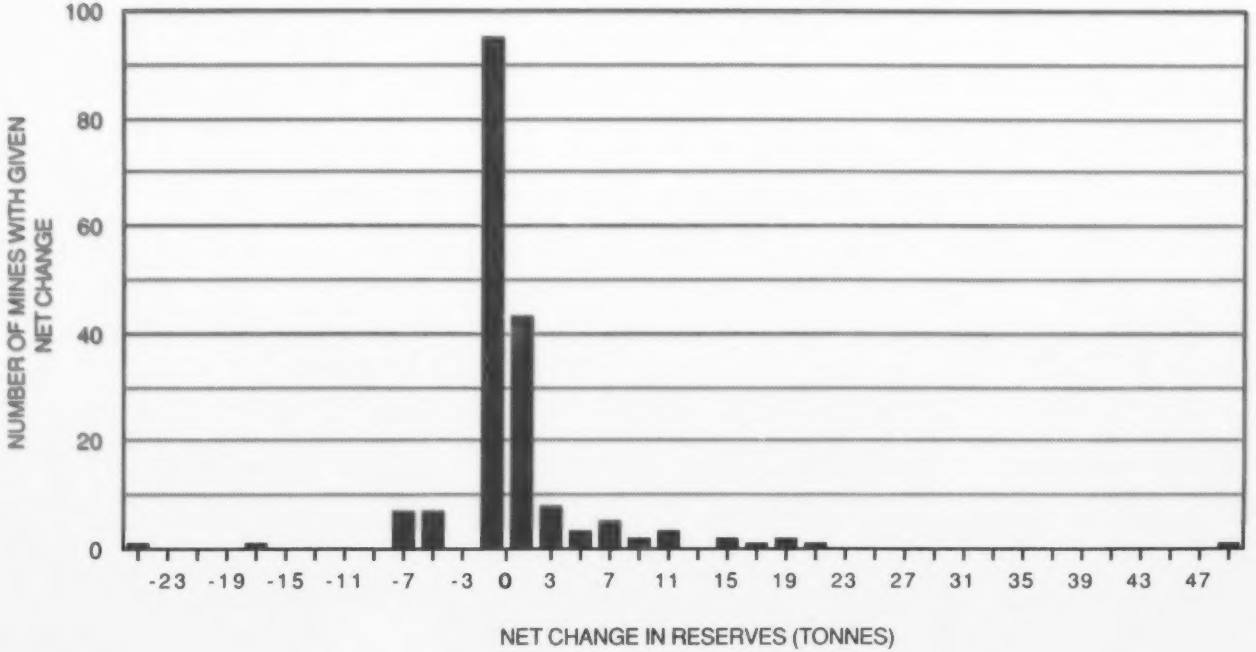
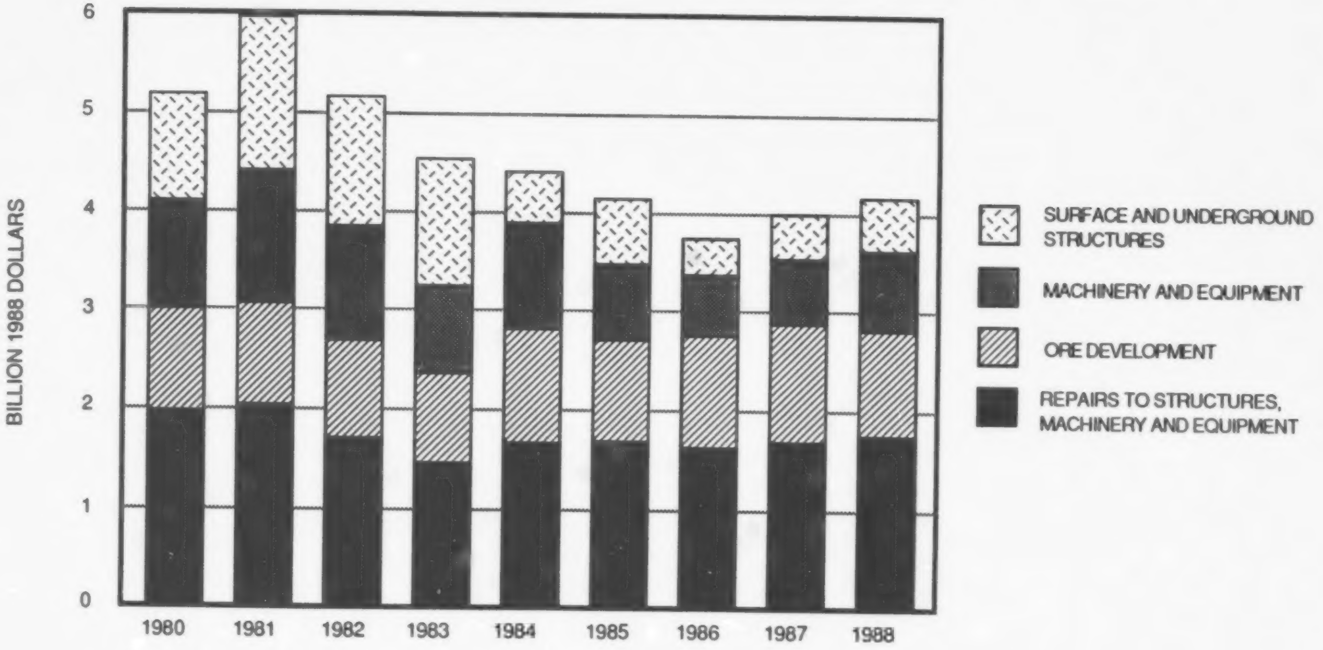


Figure 2

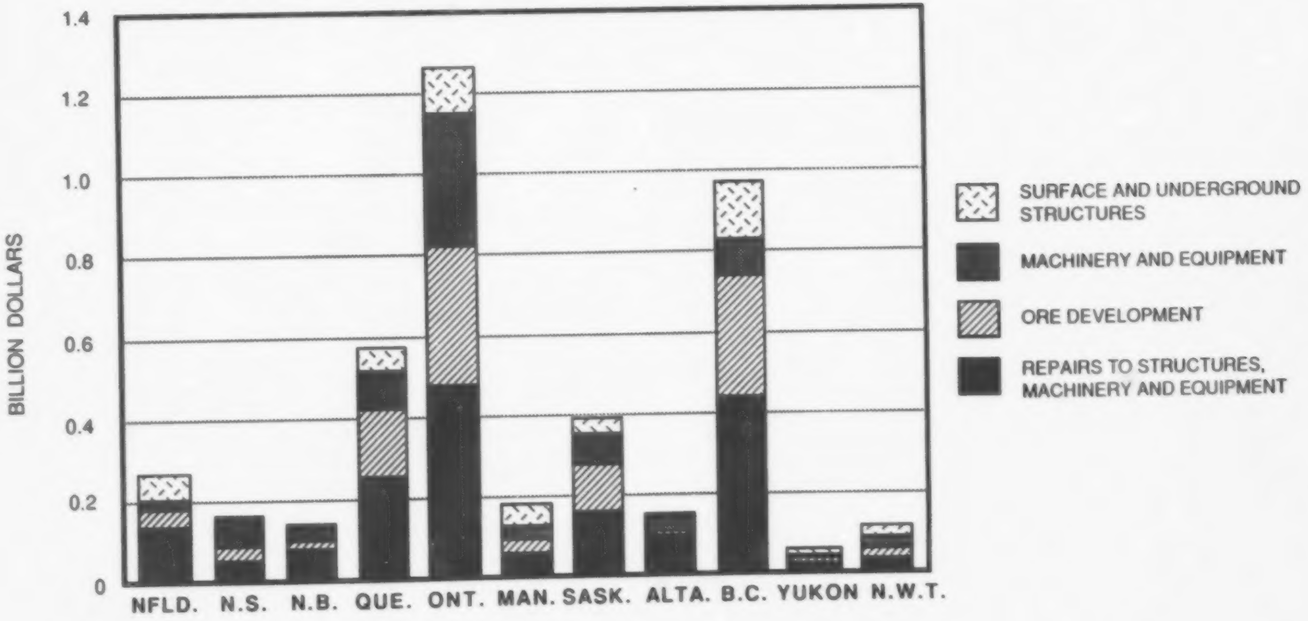
MINE INVESTMENTS IN CANADA
1980-88



Source: EMR. Based on Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1988 Preliminary Statistics.

Figure 3

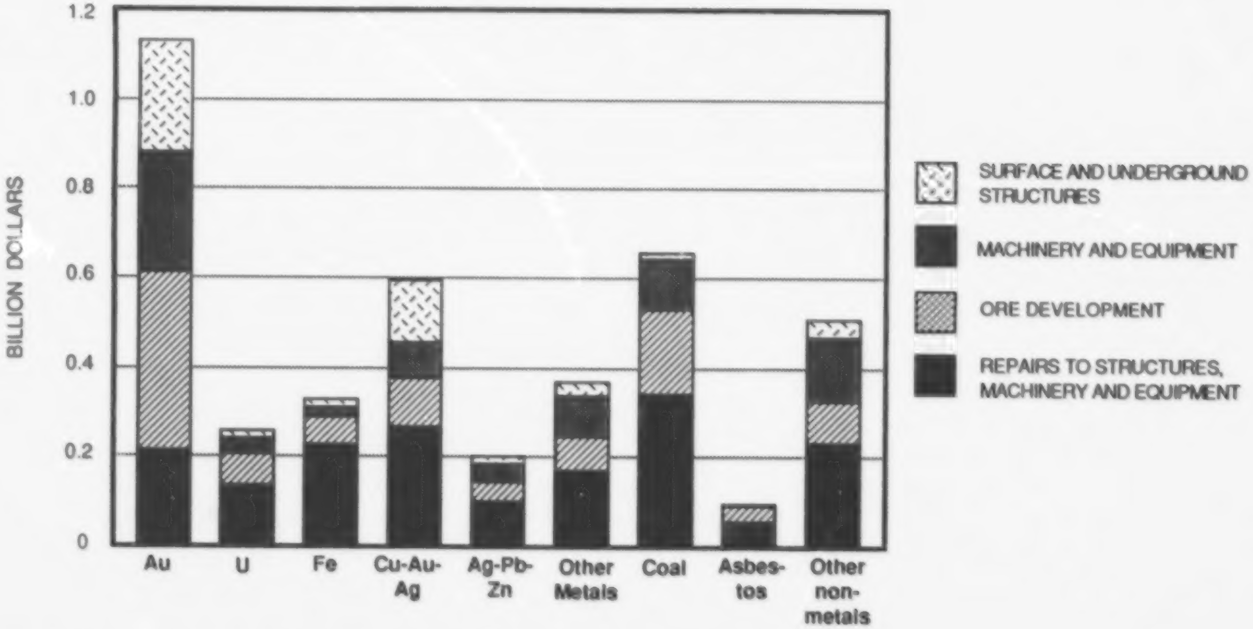
$4.2 BILLION MINE INVESTMENTS IN CANADA BY PROVINCE AND TERRITORY, 1988



Source: EMR. Based on Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1988 Preliminary Statistics.

Figure 4

$4.2 BILLION MINE INVESTMENTS IN CANADA BY INDUSTRY GROUPS, 1988



Source: EMR; Based on Statistics Canada Survey of Exploration, Development and Capital Expenditures for Mining, 1988 Preliminary Statistics.

Canadian Mineral Exploration 1989

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ACTIVITY[1]

Exploration Expenditures

In 1988, for the second year in succession, total off- and on-property field exploration expenditures were the highest ever registered in Canadian exploration history, $1167 million, up slightly from $1139 million spent in 1987. Minesite exploration (the search for new mines on the properties of existing mines) amounted to 11% of this total, i.e. $129 million. Related overhead expenditures (land costs, administration costs and exploration-related head office expenses) added about 20% to this 1988 total. Including allowances for overhead expenditures, Canadian exploration spending in 1988 totalled about $1400 million. Preliminary indications are that in 1989, on- and off-property field expenditures, including overhead, were approximately $900 million.

Although significantly lower than the spending levels of the previous two years, the $900 million spent on exploration in 1989 represents the third highest level of Canadian exploration spending ever. After adjustment for inflation, exploration spending in 1989 is at about the same level as it was in the earlier all-time Canadian exploration spending peaks that occurred in 1980 and 1981. Those earlier notable spending peaks were fuelled largely by the sharp increase in mineral-commodity prices that followed the sudden rise in the price of gold, which climbed from US$227 per troy ounce in early 1979 to US$850/troy oz. (or $1550/troy oz. in 1989 Canadian dollars) on January 21, 1980.

Flow-through Share Funding

Funds raised by flow-through shares (Table 1) covered about 60% of total Canadian exploration in 1988 and an estimated 40% of total Canadian exploration spending in 1989.

Although the count is not yet complete, the Department of Energy, Mines and Resources' (EMR's) best estimate is that, for companies listed on Canadian stock exchanges, $850 million in flow-through shares were sold in 1988, down from $1183 million in 1987.

In addition to the above placements, flow-through share issues by corporations not listed on stock exchanges may have amounted to several tens of millions of dollars in 1988 (a smaller amount in 1989); it is therefore likely that more than $1200 million worth of flow-through shares were sold in Canada in 1987, and in excess of $850 million in 1988. Flow-through share financed mining exploration amounted to $360 million in 1989 and is forecast to be over $200 million in 1990.

Claim Staking

In 1988, the total area of claims staked in Canada was down by 9% from 1987, but up in some provinces. The largest percentage increases were in New Brunswick, Alberta and the Northwest Territories. Staking was also up somewhat in Newfoundland and Saskatchewan. There was a notable decline in staking in Nova Scotia, Quebec and Ontario, with some decline in British Columbia and the Yukon. Preliminary indications for 1989 are that on a national basis the area of claims staked was down 10% from 1988.

FEDERAL-PROVINCIAL EXPLORATION SURVEY

Since 1980, EMR has made efforts towards achieving greater interprovincial consistency in the information gathered from industry on exploration activity. Coordination with provincial and territorial officials in the design of provincial surveys that allow nationwide comparisons has led to a much more reliable and detailed set of Canadian exploration data beginning with 1985.

Statistics Canada has ceased collection and publication of statistics concerning general exploration (exploration other than "on-property" or "minesite" exploration -- the search for new mines on the properties of existing producing mines), beginning with survey year 1989. To ensure the continued availability of these important statistics, EMR has taken over the federal-provincial coordination of collection of general exploration statistics. Statistics Canada will continue to collect information on "On-Property" ("Minesite") exploration, which it needs for National Accounts purposes, and will continue to cooperate with EMR, the provinces and territories so that complete annual national exploration statistics can be assembled and published by EMR (Tables 5 to 11).

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[1] Oil and gas are not covered by exploration statistics given here. In the case of new claims recorded, coal is excluded as well.

Surface Exploration Drilling

The 5 363 412 m of Canadian surface exploration drilling completed in 1988 exceeded by 13% the previous record set in 1987 (Figure 1). Preliminary indications for 1989 are that surface drilling declined by some 30% relative to 1988.

EXPLORATION EXPENDITURE BY PROVINCE AND TERRITORY - 1988

(Table 3 and Figure 2)

- The most active exploration areas were Ontario and Quebec, which jointly accounted for 58% of total Canadian exploration spending. Exploration expenditures in Ontario exceeded those in Quebec for the first time since 1977. In Ontario, 1988 field exploration expenditures were $344 million, up significantly from the $308 million spent in 1987. Field exploration expenditures for 1989 in Quebec were $328 million, down considerably from the $416 million expended in 1987.

- Field exploration expenditures in British Columbia rose to $197 million in 1988 from $143 million in 1987; in the Yukon to $39 million from $29 million; in Alberta to $4.3 million from $2.5 million; in New Brunswick to $14 million from $9 million; in Nova Scotia to $47 million from $42 million; and in Newfoundland to $39 million from $28 million. Field expenditures in Saskatchewan, $61 million, were slightly lower than the $64 million reported for 1987. Field exploration spending in Manitoba was down to $30 million in 1988 from $40 million in 1987.

EXPLORATION EXPENDITURES BY COMMODITIES SOUGHT - 1988

(Table 2 and Figure 3)

- Some 82% exploration spending in 1988 was directed at precious metals, chiefly gold. Field exploration spending for precious metals totalled $951 million in 1988, identical to 1987 spending of $951 million.

- In 1988, field exploration expenditures for platinum group elements (PGE) amounted to $17 million. PGE exploration spending is unavailable for 1987 and earlier years.

- Base metals field exploration increased to $156 million in 1988 from $129 million in 1987.

- Field exploration spending in 1988 were distributed by commodity target groups as follows:

	Percent
Precious metals (primarily gold, plus silver and platinum group elements)	82
Copper, zinc, lead and nickel	13
Uranium	2
Others (coal, miscellaneous metals, nonmetals and unspecified)	4

Note: Percentages do not add up to 100% because of rounding.

- Relative to 1987, the amounts spent on exploration in 1988 were up (+) or down (-) as follows:

Precious metals	Identical
	(percent)
Copper, zinc, lead and nickel	+21
Uranium	-15
Coal	+17

REGIONAL EXPLORATION EXPENDITURES BY COMMODITIES SOUGHT - 1988

(Figure 4)

- Gold was the principal exploration target in 1988 in all provinces and territories except Alberta (where 97% of total field exploration spending total was directed at exploration for coal and uranium, most of it at coal). Base metals exploration spending in Manitoba was essentially identical to that for precious metals.

- In Saskatchewan, expenditures for precious metals exploration ($34 million) surpassed those for uranium ($15 million) for the second successive year.

REGIONAL EXPLORATION EXPENDITURES BY TYPES OF COMPANY - 1988

(Figure 5)

- Junior companies were the dominant spenders in Quebec, British Columbia, the Northwest Territories, the Yukon and Nova Scotia. (Exploration expenditures by producing companies and their affiliate companies have been totalled for each province prior to making this comparison.)

- Producing companies with their affiliates accounted for more than half of total exploration spending in all of the other provinces.

- Foreign companies expended 97% of their exploration dollars in the Northwest Territories, Saskatchewan, Ontario, Quebec, British Columbia and Nova Scotia (listed in order of declining expenditures). Field exploration spending of $35 million by foreign companies in 1988 was only about half the $71 million (1988 dollars) spent by this group of companies in 1979, their peak spending year in Canada, when foreign companies accounted for over 18% of total Canadian non-petroleum mineral exploration spending.

- Oil companies expended 99% of their exploration dollars in British Columbia, Ontario, the Yukon, Newfoundland and the Northwest Territories (listed in order of declining expenditures), most of that amount in British Columbia and Ontario.

EXPLORATION EXPENDITURES BY TYPES OF COMPANIES AND COMMODITIES - 1988

(Figure 6)

- Of the total expenditures for precious metals exploration, junior companies contributed about 55% and producing companies and their affiliates about 42%. This represents a slight shift towards the seniors and away from the juniors in 1988 relative to the 59% and 39% contributed in 1987 respectively.

- Of the money spent on Canadian field exploration for base metals, producing companies and their affiliates provided 72% and junior companies 27%.

- In 1988, the search for precious metals accounted for 64% of the Canadian field exploration spending of foreign companies. Field exploration for uranium accounted for 28% of the field exploration spending of foreign companies, which amounted to $9.9 million in 1988, up from $5.7 million in 1987.

- Total 1988 field exploration expenditures for uranium dropped to $20.7 million in 1988 from $24.5 million in 1987. Uranium field exploration spending had been $27.3 million in 1986.

- Total 1988 field exploration expenditures for nonmetallic mineral commodities (excluding coal) were $16.8 million, up from $13 million in 1987 and $12 million in 1986. These are the highest exploration spending years for nonmetallic mineral commodities since such statistics were first gathered in 1975. The previous record spending for nonmetallic exploration was the $10 million spent in 1981.

TYPES OF COMPANIES ENGAGED IN EXPLORATION

(Table 4)

- Half (50%) of the Canadian field exploration dollars spent in 1988 were expended by junior companies, 46% by producing companies and their affiliates, 3% by foreign companies and 1% by oil companies. The junior companies spent $40 million more on field exploration than the total amount spent on field exploration by the producers and their affiliates.

- Field exploration spending by oil companies declined slightly in 1988 to $16 million from $18 million in 1987. At $16 million, spending by the oil companies remains far below the range of $78 million-$105 million (1988 dollars) this group of companies expended on field exploration annually, from the late 1960s to the early 1980s. Over the seven years 1969-75 inclusive oil companies provided between 9% and 24% of total Canadian field exploration spending, compared to a mere 1% in 1988.

Exploration Results

To date, results of an ongoing count of mineral deposits discovered in recent years indicate that over the six-year period 1983-88 inclusive, when flow-through shares were widely used to finance mineral exploration, at least 300 metallic mineral deposits were discovered in Canada, or an average of more than 50 deposits annually. The previous all-time record for the number of deposits discovered in a single year were 49 discoveries in 1980 and 50 in 1981. These two record discovery years were also years of record exploration spending.

This average of more than 50 discoveries of metallic mineral deposits per year is almost certain to increase as additional information on discoveries becomes publicly available. In contrast, an average of only 30 metal deposits were discovered annually in Canada between 1958 and 1982, a period of 25 years immediately preceding the widespread use of flow-through shares.

It is still too early to make any realistic estimate of how many metal deposits were discovered in Canada in 1989, but the number of discoveries announced to date is already significant.

DISCOVERIES BY COMMODITY TYPE,1983-88

Over the six-year period 1983-88, some 17-18% of Canadian exploration spending was directed to exploration for base metals. Base-metal deposits constitute 20% of the roughly 300 deposits discovered over this period.

Over the same six years, 70% of Canadian exploration spending was directed at precious metals, overwhelmingly at gold. Gold deposits constitute about 77% of the roughly 300 deposits discovered over this period.

OUTLOOK FOR 1990

Flow-through share financing for 1990 will likely be $150 million less than in 1989. Hence, total mineral exploration expenditures in 1990 are estimated at $750 million.

TABLE 1. FLOW-THROUGH SHARES ISSUED FOR COMPANIES LISTED ON CANADIAN STOCK EXCHANGES, 1983–89

Year	Value of Shares Issued ($ million)
1983	34
1984	139
1985	275
1986	673
1987	1 183
1988p	850
1989e	360

Sources: Montreal, Toronto, Alberta and Vancouver Stock Exchange records as compiled by Mineral Policy Sector, EMR.

p Preliminary; e Estimated.

Note: The value of flow-through shares issued in 1988 cannot be directly compared to actual 1988 exploration expenditures for the following various reasons: (i) unspent funds may have been returned to investors; (ii) as permitted by tax regulations, some of the money raised in 1988 would not have been spent until January February 1989; and (iii) some of the funds spent in January February 1988 were raised in 1987.

TABLE 2. GENERAL AND MINESITE FIELD EXPLORATION EXPENDITURES FOR BASE METALS AND PRECIOUS METALS

Year	Base Metals[1]	Precious Metals[2]
1975	63	7
1977	42	7
1979	35	12
1981	34	25
1983	42	29
1985	20	65
1986	14	76
1987	11	83
1988	13	82

Sources: 1975-83 compiled by EMR, from individual company responses to Statistics Canada exploration questionnaires, 1985-88, from the federal-provincial exploration survey.

[1] Nickel, copper, zinc and lead. [2] Gold, silver and platinum group elements (more than 95% for gold exploration in recent years).

TABLE 3. EXPLORATION ACTIVITIES BY PROVINCE – 1988

	Expenditures On– and Off–Property		Area of New Claims[1]		Surface Drilling[3]	
	($ millions)	(%)	(hectares)	(%)	(metres)	(%)
Newfoundland	37.7	3	419 184	7	235 391	4
Nova Scotia	46.7	4	423 019	7	119 484	2
New Brunswick	13.8	1	110 976	2	100 521	2
Prince Edward Island	–	–	–	–	–	–
Quebec	328.2	28	537 217	8	1 733 562	32
Ontario	343.5	29	598 632	9	1 658 884	31
Manitoba	30.0	3	162 264	3	184 937	3
Saskatchewan	61.1	5	741 944	12	286 981	5
Alberta	4.3	. . .	59 927	1	98 584	2
British Columbia	196.8	17	2 212 125[2]	35	601 127	11
Yukon Territory	38.6	3	301 713	5	139 867	3
Northwest Territories	66.5	6	739 928	12	204 074	4
Total	1 167.2	100[4]	6 306 929	100[4]	5 363 412	100[4]

Sources: For exploration expenditures and drilling: Federal-Provincial Field Expenditure Survey. For claim areas: provincial and territorial mining recorders.

[1] Excludes coal. [2] Excludes placer leases (70 000 hectares in 1987). [3] Diamond and other types of surface drilling. [4] Provincial percentages do not add exactly to 100% because of rounding.

– Nil; . . . Amount too small to be expressed.

TABLE 4. TYPES OF COMPANIES ENGAGED IN EXPLORATION – 1987 AND 1988

	Expenditures				Surface Drilling			
	1987		1988		1987		1988	
	($ millions)	(percent)	($ millions)	(percent)	(metres)	(percent)	(metres)	(percent)
Senior companies (i.e. those with a producing mine in Canada and their affiliates)	497	44	538	46	2 666 827	47	2 968 123	55
Oil companies (excluding the above)	15	1	16	1	62 540	1	76 872	1
Foreign companies (excluding the above)	36	3	35	3	155 879	3	140 721	3
Others (mainly junior mining companies)	591	52	578	50	2 791 810	49	2 177 696	41
Total	1 139	100	1 167	100	5 677 056	100	5 363 412	100

Source: Federal–Provincial Exploration Expenditures Survey.

TABLE 5 / TABLEAU 5

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal - Provincial Survey of Mining and Exploration Companies
Relevé fédéral - provincial auprès de sociétés d'exploration ou d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy Mines and Resources Ottawa
Ministère de l'Énergie des Mines et des Ressources Ottawa

PROVINCIAL DISTRIBUTION BY TYPE OF WORK (in thousands of dollars)
RÉPARTITION PROVINCIALE PAR TYPE DE TRAVAUX (en milliers de dollars)

Province	Drilling (surface + underground) Forage (surface + souterrain)				Surveys - other exploration work / Relevés - autres travaux d'exploration						Total
	Diamond / Diamant		Other / Autres		Geochemical Géochimie	Geology Géologie	Geophysical/Géophysique		Rock Work Travaux dans la roche	Other Field Costs Autres travaux	
	Metres (10^3)	Cost Coût	Metres (10^3)	Cost Coût			Ground Au sol	Airborne Aéroportée			
Alberta	8	788	90	2035	84	273	280	70	0	774	4304
British Columbia Colombie-Britannique	683	59944	35	1973	9153	17214	6996	1448	43341	56700	196769
Manitoba	198	17635	2	201	985	2359	2427	571	862	5006	30046
New-Brunswick Nouveau-Brunswick	94	7266	7	118	1288	1584	879	192	188	2258	13773
Newfoundland Terre-Neuve	235	20122	1	20	2689	7561	1854	919	795	3728	37688
Nova Scotia Nouvelle-Écosse	130	10680	0	0	2035	2575	689	72	15778	14893	46722
N.W. Territories T. N.-O.	222	29877	0	0	1906	9012	2492	2380	11831	8981	66479
Ontario	2125	141497	12	2375	11600	24921	12917	4550	85193	60503	343556
Quebec Québec	2112	148656	28	1927	7391	24949	13302	1472	37914	92549	328160
Saskatchewan	276	26124	11	254	2124	4558	4806	1202	6161	15871	61100
Yukon Territory Territoire du Yukon	123	14920	25	1563	2055	3502	1459	562	4801	9708	38570
CANADA	6206	477509	211	10466	41310	98508	48101	13438	206864	270971	1167167

1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.
2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.
2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

TABLE 6 / TABLEAU 6

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal – Provincial Survey of Mining and Exploration Companies
Relevé fédéral – provincial auprès de sociétés d'exploration ou d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources, Ottawa
Ministère de l'Énergie, des Mines et des Ressources, Ottawa

DISTRIBUTION OF ACTIVITIES BY TYPE OF COMPANY (in thousands of dollars)
RÉPARTITION DES ACTIVITÉS PAR TYPE DE SOCIÉTÉ (en milliers de dollars)

Type of Company Type de société	Drilling (surface + underground) Forage (surface + souterrain)				Surveys · other exploration work / Relevés · autres travaux d'exploration						Total
	Diamond / Diamant		Other / Autres		Geochemical Géochimie	Geology Géologie	Geophysical/Géophysique		Rock Work Travaux dans la roche	Other Field Costs Autres travaux	
	Metres (10³)	Cost Coût	Metres (10³)	Cost Coût			Ground Au sol	Airborne Aéroportée			
1. Companies with a producing mine in Canada Sociétés possédant une mine en production au Canada	2418	173920	136	6090	12731	31197	14220	3604	56111	75586	373459
2. Affiliates of (1) Sociétés affiliées à (1)	1247	82303	24	773	6915	15434	6505	1537	30229	21219	164915
3. Oil companies Sociétés pétrolières	76	6701	1	20	347	2066	586	0	607	5456	15783
4. Foreign companies excluding (3) Sociétés étrangères, excluant (3)	136	16388	5	381	2180	3053	2040	1331	2278	7212	34863
5. Others (mainly junior mining companies) Autres (principalement des petites sociétés)	2328	198199	46	3204	19139	46758	24752	6966	117641	161499	578158

1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.

2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

TABLE 7 / TABLEAU 7

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal – Provincial Survey of
Mining and Exploration Companies
Relevé fédéral – provincial
auprès de sociétés d'exploration
ou d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and
Resources, Ottawa
Ministère de l'Énergie, des Mines
et des Ressources, Ottawa

DISTRIBUTION OF EXPENDITURES BY COMMODITIES SOUGHT (in thousands of dollars)
RÉPARTITION DES DÉPENSES PAR PRODUIT MINÉRAL RECHERCHÉ (en milliers de dollars)

Province	Metals / Métaux					Nonmetals Non-métaux	Coal Charbon	Commodity not specified Produit non spécifié	Total
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other metals Autres métaux				
Alberta	0	114	0	1076	0	19	3095	0	4304
British Columbia Colombie-Britannique	22633	161992	0	0	1896	580	4914	4756	196771
Manitoba	14436	14406	0	0	112	100	0	990	30044
New-Brunswick Nouveau-Brunswick	5358	7723	0	0	366	142	170	15	13774
Newfoundland Terre-Neuve	16079	21154	0	15	4	272	0	165	37689
Nova Scotia Nouvelle-Écosse	456	45094	18	0	499	487	156	13	46723
N.W. Territories T. N.-O.	3084	57383	0	4094	785	561	0	573	66480
Ontario	40873	293613	0	7	86	8309	0	670	343558
Quebec Québec	37772	284064	0	324	1899	4104	0	0	328163
Saskatchewan	8717	34382	0	15197	0	2183	129	492	61100
Yukon Territory Territoire du Yukon	6810	31502	0	0	48	1	0	210	38571
CANADA	156218	951427	18	20713	5695	16758	8464	7884	1167177

1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.

2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

TABLE 8 / TABLEAU 8

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal – Provincial Survey of
Mining and Exploration Companies
Relevé fédéral – provincial
auprès de sociétés d'exploration
ou d'exploitation minière

PREPARED BY / ETABLI PAR
Department of Energy, Mines and
Resources, Ottawa
Ministère de l'Énergie, des Mines
et des Ressources, Ottawa

DISTRIBUTION OF EXPENDITURES BY TYPE OF COMPANY AND BY COMMODITIES SOUGHT (in thousands of dollars)
RÉPARTITION DES DÉPENSES PAR TYPE DE SOCIÉTÉ ET PAR PRODUIT MINÉRAL RECHERCHÉ (en milliers de dollars)

Type of Company Type de société	Metals / Métaux					Nonmetals Non-métaux	Coal Charbon	Commodity not specified Produit non spécifié
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other metals Autres métaux			
1. Companies with a producing mine in Canada Sociétés possédant une mine en production au Canada	80256	269450	0	9153	1698	4497	3317	5088
2. Affiliates of (1) Sociétés affiliées à (1)	31921	131606	0	223	9	27	357	975
3. Oil companies Sociétés pétrolières	1578	9566	0	0	39	0	4599	0
4. Foreign companies excluding (3) Sociétés étrangères, excluant (3)	668	22152	0	9852	376	1814	0	0
5. Others (mainly junior mining companies) Autres (principalement des petites sociétés)	41795	518856	18	1484	3573	10419	191	1821

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1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.

2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.

2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

TABLE 9 / TABLEAU 9

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal - Provincial Survey of Mining and Exploration Companies
Relevé fédéral - provincial auprès de sociétés d'exploration ou d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources, Ottawa
Ministère de l'Énergie, des Mines et des Ressources, Ottawa

DISTRIBUTION OF SURFACE AND UNDERGROUND DRILLING BY COMMODITIES SOUGHT (in thousands of metres)
RÉPARTITION DU FORAGE DE SURFACE ET SOUTERRAIN PAR PRODUIT MINÉRAL RECHERCHÉ (en milliers de mètres)

Province	Metals / Metaux					Nonmetals Non-métaux	Coal Charbon	Total
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other metals Autres métaux			
Alberta	0	0	0	7	0	0	91	98
British Columbia Colombie-Britannique	104	592	0	0	5	2	14	717
Manitoba	104	96	0	0	0	0	0	200
New-Brunswick Nouveau-Brunswick	43	44	0	0	6	2	6	101
Newfoundland Terre-Neuve	157	77	0	0	0	1	0	235
Nova Scotia Nouvelle-Écosse	2	119	0	0	1	8	1	131
N.W. Territories T. N.-O.	21	190	0	9	1	0	0	221
Ontario	290	1816	0	0	0	31	0	2137
Quebec Québec	293	1803	0	2	18	24	0	2140
Saskatchewan	49	133	0	99	0	2	4	287
Yukon Territory Territoire du Yukon	23	126	0	0	0	0	0	149
CANADA	1086	4996	0	118	30	70	115	6416

1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.
2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.
2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

TABLE 10 / TABLEAU 10

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal - Provincial Survey of Mining and Exploration Companies
Relevé fédéral - provincial auprès de sociétés d'exploration ou d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources, Ottawa
Ministère de l'Énergie, des Mines et des Ressources, Ottawa

DISTRIBUTION OF SURFACE AND UNDERGROUND DRILLING BY TYPE OF COMPANY AND BY COMMODITY SOUGHT (in thousands of metres)
RÉPARTITION DU FORAGE DE SURFACE ET SOUTERRAIN PAR TYPE DE SOCIÉTÉ ET PAR PRODUIT MINÉRAL RECHERCHÉ (en milliers de mètres)

Type of Company Type de société	Metals / Metaux					Nonmetals Non-métaux	Coal Charbon	Total
	Base Communs	Precious Précieux	Iron Fer	Uranium	Other metals Autres métaux			
1. Companies with a producing mine in Canada Sociétés possédant une mine en production au Canada	610	1750	0	63	18	20	92	2553
2. Affiliates of (1) Sociétés affiliées à (1)	276	977	0	0	0	0	18	1271
3. Oil companies Sociétés pétrolières	9	63	0	0	0	0	5	77
4. Foreign companies excluding (3) Sociétés étrangères, excluant (3)	4	84	0	50	1	2	0	141
5. Others (mainly junior mining companies) Autres (principalement des petites sociétés)	189	2119	0	5	11	48	1	2373

1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.
2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.
2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

TABLE 11 / TABLEAU 11

GENERAL EXPLORATION PLUS MINESITE EXPLORATION[1] FIELD[2] EXPENDITURES, 1988

DÉPENSES ENGAGÉES SUR LE TERRAIN[2] POUR L'EXPLORATION DE NATURE GÉNÉRALE ET L'EXPLORATION À LA MINE[1], 1988

SOURCE Federal - Provincial Survey of Mining and Exploration Companies
Relevé fédéral - provincial auprès de sociétés d'exploration ou d'exploitation minière

PREPARED BY / ÉTABLI PAR
Department of Energy, Mines and Resources, Ottawa
Ministère de l'Énergie, des Mines et des Ressources, Ottawa

PROVINCIAL DISTRIBUTION OF EXPENDITURES BY TYPE OF COMPANY (in thousands of dollars)
RÉPARTITION PROVINCIALE DES DÉPENSES PAR TYPE DE SOCIÉTÉ (en milliers de dollars)

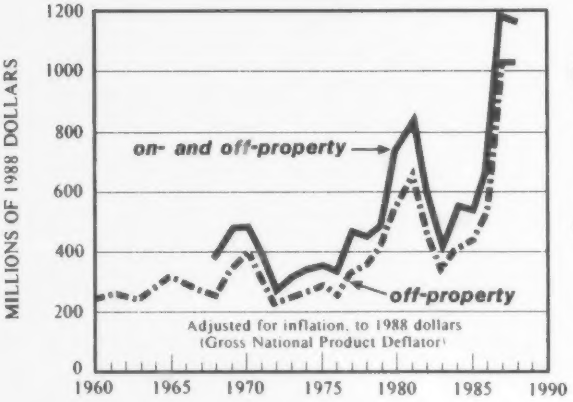
Province	(1) Companies with a Producing mine in Canada Sociétés possédant une mine en production au Canada	(2) Affiliates of (1) Sociétés affiliées à (1)	(3) Oil companies Sociétés pétrolières	(4) Foreign companies excluding (3) Sociétés étrangères, excluant (3)	(5) Other (mainly junior mining companies) Autres (principalement des petites sociétés)	Total
Alberta	3718	362	155	0	69	4304
British Columbia Colombie-Britannique	68868	7477	5665	3047	111713	196770
Manitoba	16949	7711	0	600	4785	30045
New-Brunswick Nouveau-Brunswick	3493	6267	0	208	3806	13774
Newfoundland Terre-Neuve	5068	21551	1947	29	8294	37689
Nova Scotia Nouvelle-Écosse	1357	10921	0	2286	32157	46721
N.W. Territories T. N.-O.	8400	13191	1482	10516	32892	66481
Ontario	125905	56836	4367	7206	149241	343555
Quebec Québec	101679	34474	23	3304	188682	328162
Saskatchewan	29177	1879	0	7614	22429	61099
Yukon Territory Territoire du Yukon	8042	4245	2144	50	24089	38570
CANADA	373456	164914	15783	34860	578157	1167170

1. Exploration activity does not include exploration for extentions to deposits already being mined or committed to production.
2. Related overhead expenditures (land cost, field administration costs and exploration-related head office expenses) are not included.

1. L'activité d'exploration exclut l'exploration visant le prolongement de gisements déjà en production ou destinés à la production.
2. Les frais généraux connexes (frais d'acquisition des terres, frais d'administration sur place et frais d'administration centrale en rapport avec l'exploration) ne sont pas inclus.

Figure 1

MEASURES OF EXPLORATION ACTIVITY

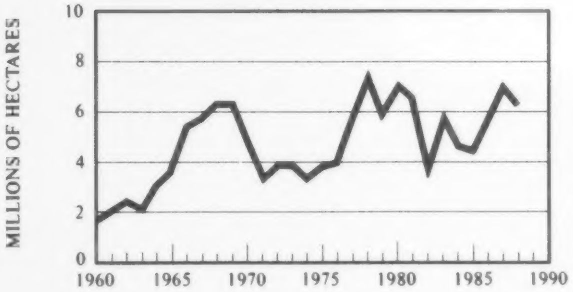


Adjusted for inflation, to 1988 dollars
(Gross National Product Deflator)

(a)

FIELD EXPENDITURES ON MINERAL EXPLORATION (All minerals except oil and gas)

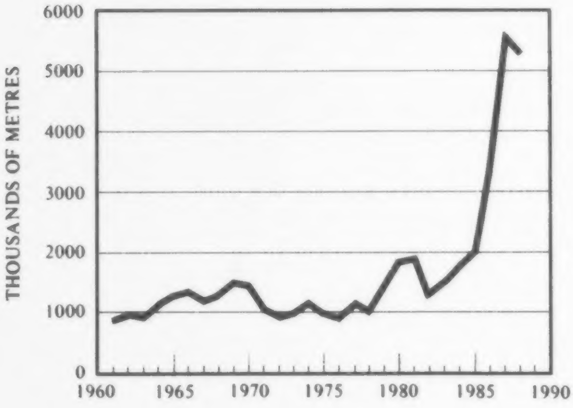
SOURCES: Statistics Canada's Annual Survey of Exploration, Development, Capital and Repair Expenditures (Catalogue 61-216) and Federal-Provincial Exploration and Development Survey.



(b)

AREA OF MINING CLAIMS AND CLAIM BLOCKS RECORDED

SOURCE: Gathered by EMR from Provincial and Territorial Mining Recorders.



(c)

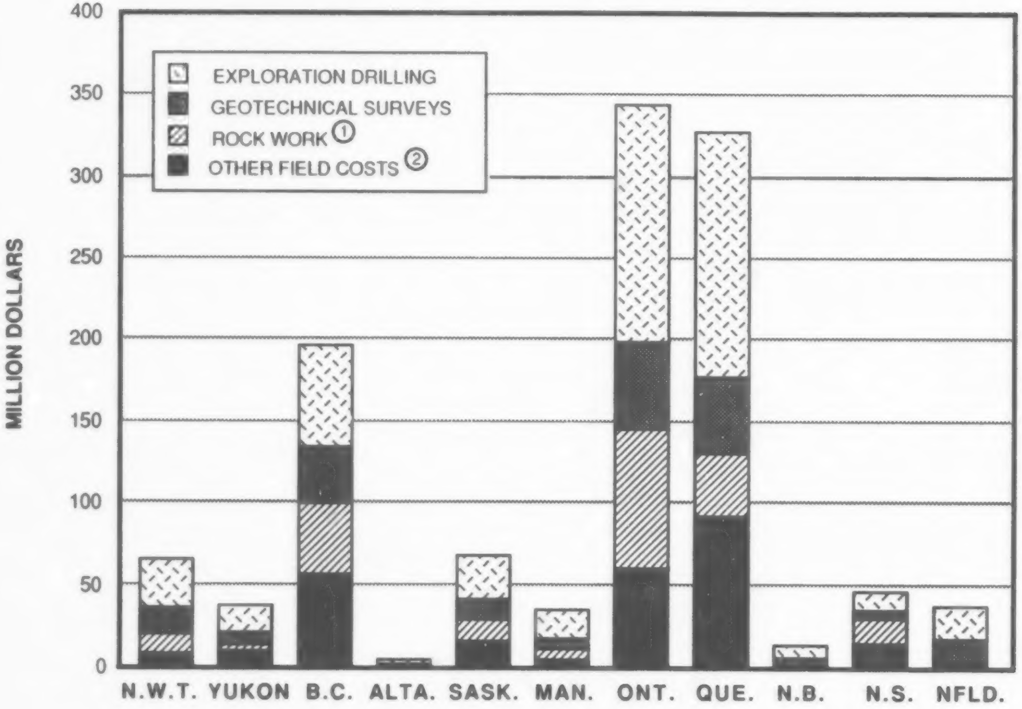
SURFACE DIAMOND DRILLING (All minerals except oil and gas)

SOURCES: Statistics Canada (Catalogue 26-201) and Federal-Provincial Exploration and Development Survey.

Figure 2

EXPLORATION EXPENDITURES BY PROVINCE AND TERRITORY - 1988

Field Work - Physical Work and Surveys



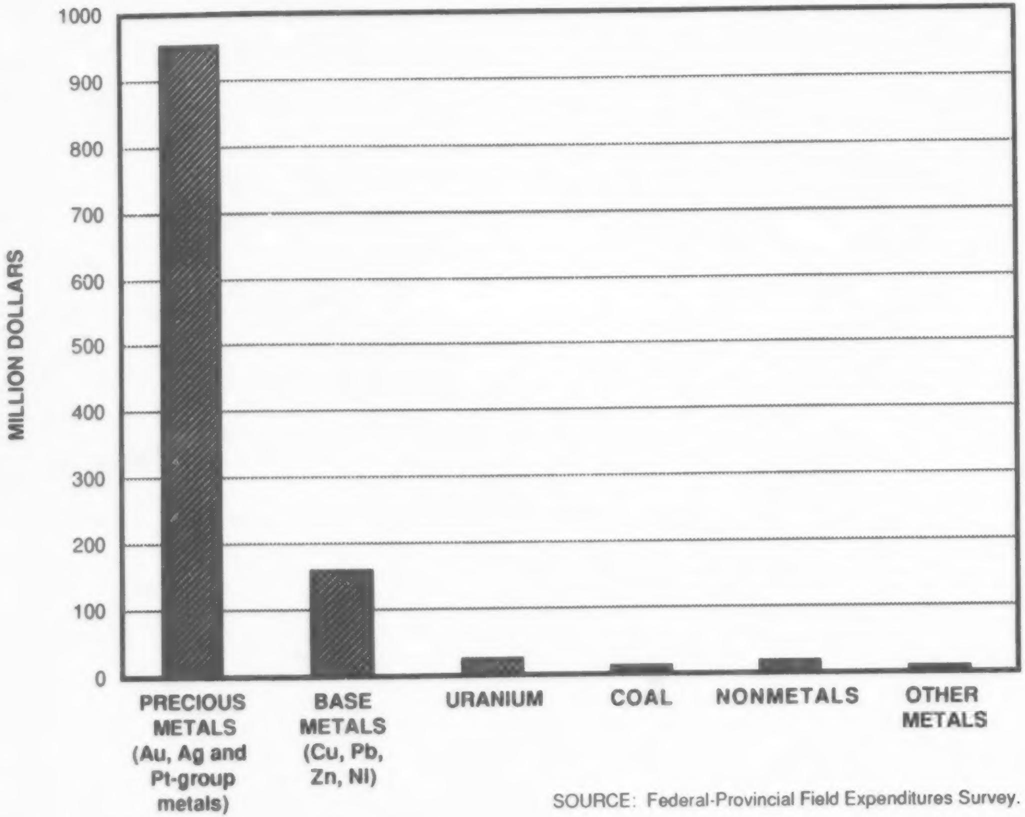
① Such as Stripping, Trenching, Shaft-Sinking and Underground Work.
② Such as Field Supervision and Line Cutting.

SOURCE: Federal-Provincial Field Expenditures Survey.

Figure 3

EXPLORATION EXPENDITURES BY COMMODITIES SOUGHT - 1988

Field Work - Physical Work and Surveys

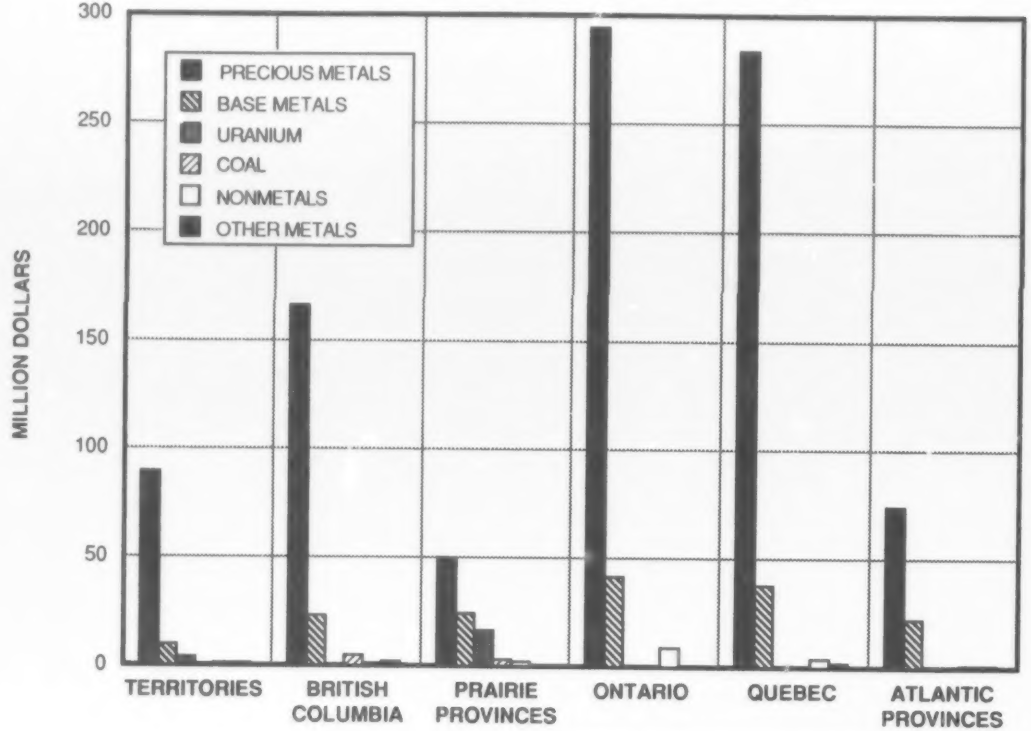


SOURCE: Federal-Provincial Field Expenditures Survey.

Figure 4

REGIONAL EXPLORATION EXPENDITURES BY COMMODITIES SOUGHT - 1988

Field Work - Physical Work and Surveys

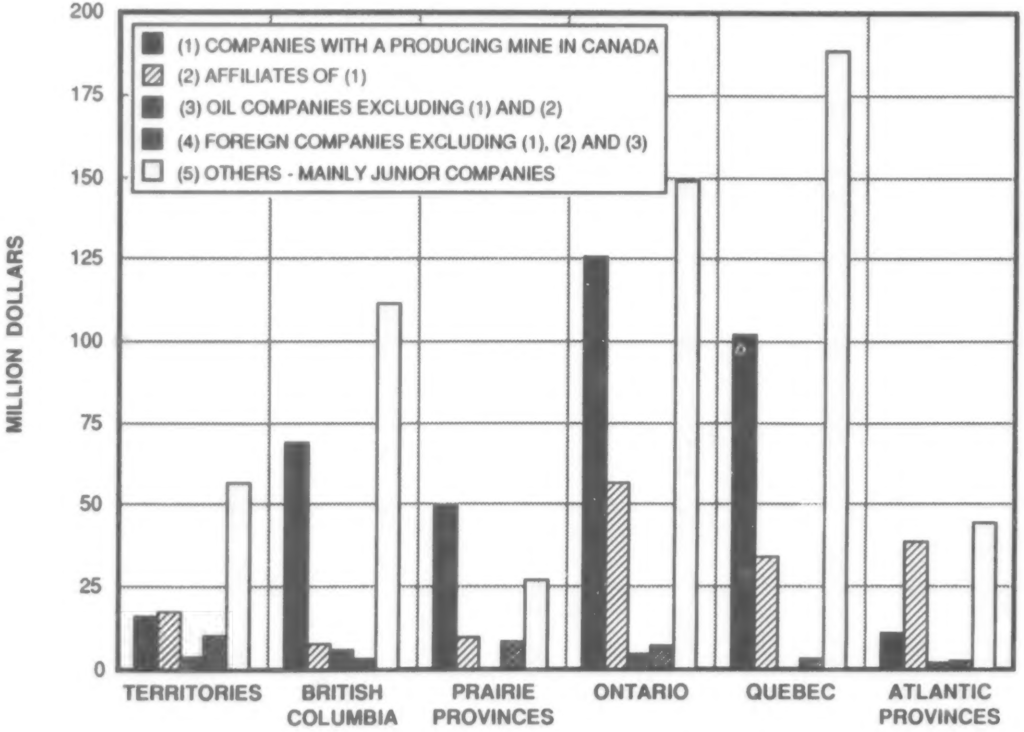


SOURCE: Federal-Provincial Field Expenditures Survey.

Figure 5

REGIONAL EXPLORATION EXPENDITURES BY TYPES OF COMPANIES - 1988

Field Work - Physical Work and Surveys

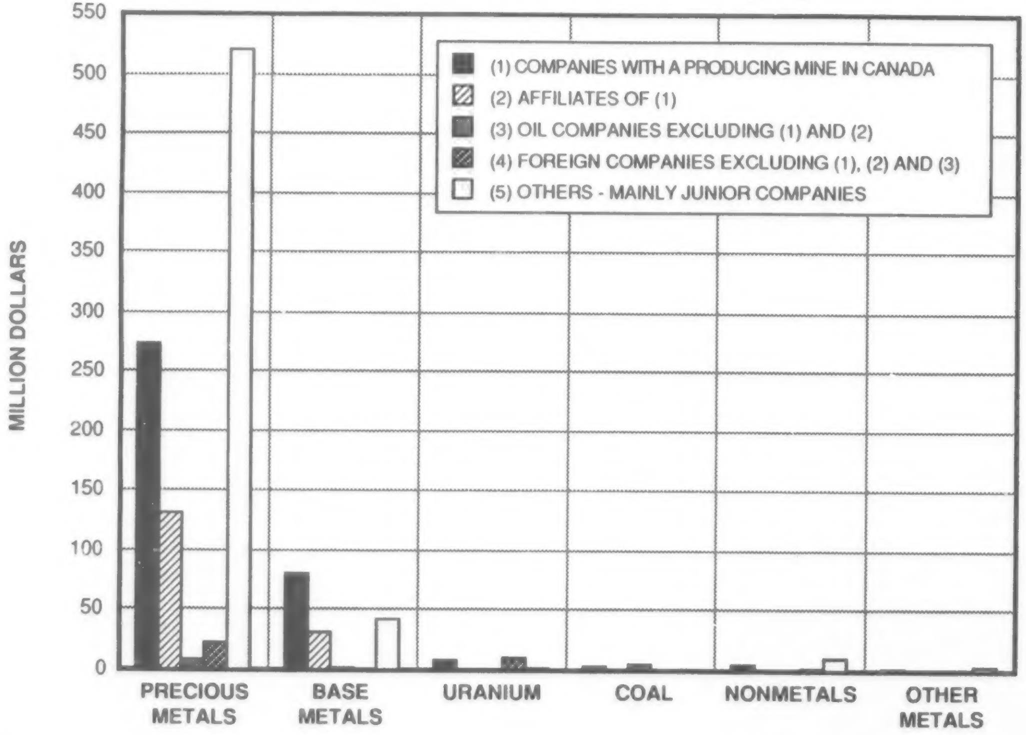


SOURCE: Federal-Provincial Field Expenditures Survey.

Figure 6

EXPLORATION EXPENDITURES BY TYPES OF COMPANIES AND COMMODITIES - 1988

Field Work - Physical Work and Surveys



SOURCE: Federal-Provincial Field Expenditures Survey.

Aluminum

1989

G. Bokovay

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Aluminum demand remained relatively strong through 1989 although there was some build-up of aluminum inventories and further weakening of metal prices. While the deterioration of prices since 1988 has been significant, they are now considered to be more realistic in terms of market fundamentals. Meanwhile, the recent increase of metal stocks has eased the extremely tight supply situation that plagued the market in 1988.

Despite some signs that economic growth may be slowing, particularly in North America, it is expected that the aluminum market will remain relatively strong through 1990 and that prices should recover in the second half of the year. However, in the longer term, it is possible that a price down-turn could occur in the early 1990s if consumption fails to keep pace with the expected increase in world smelting capacity, much of which is being built in Canada. While this can be expected to depress industry profitability in the short term and is likely to force the closure of high cost production capacity in Europe and the United States, it should help to maintain aluminum's competitiveness with other materials.

CANADIAN DEVELOPMENTS

Canadian production of primary aluminum in 1989 was 1.555 Mt compared to 1.535 Mt in 1988. Canadian exports of primary smelter products during the first nine months of 1989 were 874 553 t, up slightly from the same period in 1988. Exports to the United States totalled 608 162 t, virtually unchanged from the same period in 1988.

Three companies produce primary aluminum in Canada: Alcan Smelters and Chemicals Limited, a subsidiary of Alcan Aluminium Limited; Canadian Reynolds Metals Company, Limited, a subsidiary of Reynolds Metals Company of the United States; and Aluminerie de Bécancour Inc. (A.B.I.), a joint venture of Pechiney of France, Reynolds Metals and Alumax Inc. of the United States, and the Government of Quebec through Société générale de financement du Québec (SGF).

Alcan has smelters at Jonquière, Grande Baie, Île Maligne, Shawinigan, and Beauharnois, Quebec, and Kitimat, British Columbia. It also has a new smelter at Laterrière, Quebec, where the first 50 000 t/y smelting capacity was completed during the fourth quarter of 1989. With the permanent closure of one 22 000 t/y Soderberg potline in December, and excluding three other Soderberg potlines that have not operated since 1984, Alcan's total Canadian smelting capacity at year-end was 1 051 000 t/y. Canadian Reynolds operates one smelter at Baie Comeau with a capacity of 272 000 t/y and A.B.I.'s smelter at Bécancour has a capacity of 240 000 t/y.

Alcan is the only domestic producer of alumina, the principal raw material for aluminum metal production. The company's refinery, which is located at Jonquière, Quebec, has a capacity of approximately 1.2 Mt/y of metallurgical and commercial grade alumina. Production in 1988 was 992 600 t.

Bauxite requirements for this refinery are imported principally from Brazil, Guinea, Sierra Leone and Guyana. Metallurgical alumina from Jonquière, which is consumed at Alcan's reduction facilities in Quebec, is supplemented with imported material, principally from Jamaica. The company's Kitimat plant is supplied with alumina mainly from Australia.

During 1989, alumina for the Canadian Reynolds smelter in Baie Comeau and the A.B.I. smelter at Bécancour was imported from the United States. However in 1990, it is expected that about 50% of the alumina requirements at the Bécancour plant will come from Australia.

At the end of 1989, all Canadian aluminum smelters, with the exception of Alcan's new Laterrière plant, were being operated at full capacity. While Alcan had planned to bring the entire first phase of Laterrière, representing 50 000 t/y of capacity, on-stream during the fourth quarter of 1989, the company was able to operate the new facility at only 40% of available capacity due to a shortage of electric power caused by unusually dry weather conditions in eastern Canada. The power shortage also forced Alcan to permanently close an old 22 000 t/y Soderberg potline at its Arvida smelter in Jonquière, four months ahead of schedule. While it is unlikely that there will be an actual decline in Alcan's output, the company is expected to lose about 14 000 t of output compared to planned levels during the last quarter of 1989 and the first quarter of 1990.

With Alcan's reservoirs in the upper Lac St-Jean watershed area at less than 50% of capacity at the end of 1989, the avoidance of future cutbacks by the company is dependent upon the return to more normal precipitation levels. Alcan did purchase some power from Hydro-Québec during 1989 in order to maintain its own water inventories, but the provincial utility announced at year-end that it was cutting off clients like Alcan, who generate their own power, because of similar water shortages. For the time being, the Hydro-Québec cuts will have no effect on other aluminum producers in Quebec.

Despite these problems, the Laterrière smelter project remains on schedule, with completion of the 200 000 t/y plant expected in March 1991. Laterrière represents the first phase of a 25-year, $3 billion modernization program by Alcan at its aluminum smelting operations in the province of Quebec. In addition to significant improvements in operating cost efficiencies and working conditions, the replacement of old Soderberg potlines with new prebake technology will significantly reduce atmospheric emissions of carbon particles containing polycyclic aromatic hydrocarbons.

With the start-up of each phase of the Laterrière project, Alcan plans to permanently close a corresponding amount of capacity at its Arvida smelter in Jonquière. Altogether, fourteen of eighteen Soderberg potlines at Arvida are expected to be closed by the end of 1991.

Phase two of Alcan's Quebec modernization program includes the construction of a new smelter at Alma to replace the remaining four Soderberg potlines at Arvida as well as the 73 000 t/y capacity at the company's IsleMaligne smelter. While few details of this project have been released, it is likely that this facility will have a capacity of at least 200 000 t/y and come on-stream in the late 1990s. According to Alcan, several different technologies are under consideration including the company's own A-310 prebake technology that offers significant energy savings and increased productivity.

The final phase of Alcan's modernization program will see the construction of an additional new smelter to replace aging Soderberg capacity at the company's Shawinigan and Beauharnois smelters. While the company has not announced the site for this new facility, there has been speculation that it will be somewhere in the Saint Maurice Valley.

On March 15, 1989, Reynolds Metals Company announced a $500 million expansion of its Baie Comeau smelter which will increase capacity by 120 000 t/y to 400 000 t/y by the end of 1991. Employment will increase by 250 to about 2000. In June, the company's Canadian subsidiary, Canadian Reynolds Metals Company, Limited, signed a new three-year labour contract with production workers at the Baie Comeau smelter. The new collective agreement will be in force until June 30, 1992.

Reynolds, as part of the A.B.I. consortium, is also involved in a 120 000 t/y expansion of the Becancour smelter. This expansion, which is also expected to come on-stream in 1991, will cost $550 million.

Alumax Inc. of the United States announced on August 15, 1989, that it was proceeding with the construction of a new 215 000 t/y aluminum smelter at Deschambault, Quebec, 70 km west of Quebec City. It is expected that the $1 billion plant will come on-stream in the spring of 1992 and will employ about 500 workers. While the Government of Quebec announced that it had contributed $23 million to improve infrastructure in the area, it is not directly involved in financing the project.

The six member companies of Aluminerie Alouette Inc. agreed on September 1, 1989, to construct a new aluminum smelter at Sept-Îles, Quebec. The first phase, consisting of 215 000 t/y capacity, is expected to come on-stream in 1992 while a second phase of similar size is planned for 1995. The entire project is expected to cost $2.3 billion. The members of the Alouette consortium are: Vereinigte Aluminium-Werke AG (VAW), 20%; Austria Metall Aktiengesellschaft, 20%; Hoogovens Groep BV, 20%; Société générale de financement du Québec (SGF), 20%; Kobe Steel, Ltd., 13.33%; and Marubeni Corporation, 6.67%. It is expected that both the Alouette and Alumax projects will utilize Pechiney's new 300 000-amp smelting technology.

On September 1, 1989, Transport Minister Benoît Bouchard announced a $78.8 million program to improve facilities and transportation infrastructure at the Port of Sept-Îles in order to accommodate traffic generated by the new Alouette smelter. This will include new handling and ship-offloading equipment as well as a rail-ferry terminal. On November 24, 1989, the governments of Canada and Quebec signed an agreement whereby each would pay $5.1 million to the City of Sept-Îles for the construction of industrial infrastructure required for the Alouette project. This will include the installation of sewer and water supply mains, the construction of a pumping station and the development of an access road to the plant site.

At the beginning of December, the closure of the lower St. Lawrence Seaway system, due to a strike of Canadian Coastguard personnel, threatened to disrupt supplies of alumina to eastern Canadian smelters and particularly to the A.B.I. smelter at Bécancour. However, the passage of legislation a short time later ended the work stoppage and a crisis was avoided.

Alcan announced at the end of February that it had agreed to buy the Canadian subsidiary of Hunter Douglas N.V. of the Netherlands. The acquisition included an aluminum siding plant in Pointe-Claire, Quebec as well as sixteen distribution centres across Canada. In November, Alcan announced that it planned to close its Warden aluminum siding plant in Scarborough by March 1990 and to transfer production to its new Pointe-Claire facility. In January 1990, Alcan announced that its Alcan Wire and Cable unit would close the welding wire and metallizer wire lines at its Saint-Maurice fabrication plant in Shawinigan, Quebec. The closure will affect about 42 employees, including 16 who were laid off during the fall of 1989.

It was reported in December that Wabush Alloys Inc. of the United States had agreed to purchase the business and certain assets of Metal & Alloys Company Limited's secondary aluminum facility in Toronto. Wabush Alloys, the largest secondary aluminum producer in the United States, operates five secondary smelters in that country.

In January 1990, Canadian Reynolds announced that it would build a new plant at Bécancour, Quebec, that will produce redraw rod for the company's aluminum cable manufacturing activities in North America. The $41.8 million facility, which will have a capacity of 80 000 t/y, is expected to come on-stream at the end of 1991. The plant will employ about 40 workers.

WORLD DEVELOPMENTS

Western world primary aluminum production in 1989 is estimated at 14.35 Mt, compared to 13.80 Mt in 1988 and 12.88 Mt in 1987. For 1989, capacity utilization at smelters in the western world was about 98.5%.

According to press reports based on a study by Anthony Bird and Associates, the weighted average cost of non-socialist production in mid-1989 was US60.6¢/lb. compared to 52.9¢ in 1988 and 45.8¢ in 1987. On an individual country basis, Venezuela had the lowest cost at 45¢, followed by Australia and Canada at 54¢, West Germany and Italy at 66¢ and the United States at 67¢. On a company basis, Comalco Ltd. was the lowest cost producer at 58¢, with Alcan at 59¢, Aluminum Company of America (Alcoa) at 60¢, Reynolds Metals at 63¢, Kaiser Aluminum & Chemical Corporation at 69¢ and Swiss Aluminium Limited (Alusuisse) at 70¢.

The report attributed much of the increase to a dramatic rise in alumina costs, from an average of US$198/t to $258/t. In addition, the report cited the recommissioning of high-cost smelters in response to metal shortages in 1988 as a contributing factor.

United States

With one minor exception, U.S. primary smelters were operating at full capacity at the end of 1989. In July, Alcoa cut production at its Wenatchee, Washington smelter by 42 000 t/y due to both the deterioration of spot metal prices and alumina supply problems caused by a strike at the company's 50%-owned Jamalco refinery in Jamaica. While the strike in Jamaica was settled quickly, Alcoa maintained the shutdown at the Wenatchee plant.

In February 1989, Kaiser Aluminum & Chemical Corporation completed the sale of its 148 000 t/y smelter at Ravenswood, West Virginia to Stanwich Partners Inc. The sale also included a sheet and plate rolling mill at Ravenswood along with a can scrap reclamation centre at Bedford, Indiana. In July, the new operating company, Ravenswood Aluminum Corp., announced that it planned to re-activate a 37 500 t/y potline at its smelter that has been idle since 1981. The company hoped to have this line back on-stream by the first quarter of 1990.

Columbia Aluminum Corp. completed the start-up of its 163 000 t/y Goldendale, Oregon smelter in March 1989. The smelter was purchased from Comalco Limited in 1987. Meanwhile, Vanalco Inc. also completed the start-up of its 115 000 t/y smelter at Dalles, Washington by the end of 1989. This plant was purchased from Alcoa in June 1987.

In September, Hurricane Hugo caused a power outage to the 180 000 t smelter at Mt. Holly, South Carolina owned jointly by Alumax (73.33%) and Clarendon Ltd. (26.67%). Although it was originally anticipated that it would take about 20 weeks to bring the plant back to full production, this was achieved by early December. Hurricane Hugo also caused significant damage to the alumina refinery at St. Croix, U.S. Virgin Islands, which was scheduled to be restarted in early 1990. The 635 000 t/y refinery, which had been closed in April 1985, was sold in May 1989 by Martin Marietta Corporation to Virgin Islands Alumina Inc., a subsidiary of Clarendon Ltd.

Despite a strike at Noranda Aluminum, Inc.'s New Madrid, Missouri smelter, which began on September 1, 1989 and lasted until early December, production at this facility was maintained by supervisory personnel. A strike at Commonwealth Aluminum Corp.'s 180 000 t/y Lewisport, Kentucky rolling mill, which began on August 1, 1989, forced the company to reduce output at the facility to 25% of capacity. The strike was settled in mid-October. Commonwealth is a subsidiary of Comalco Limited of Australia.

Alcan Aluminium Limited announced a number of new investments in the United States during 1989. In May, the company reported that it planned to invest US$175 million over the next years at its sheet rolling mill at Oswego, New York. The project includes the modernization of the hot rolling mill, a new melting and casting centre, a pusher furnace, a high speed slitting line and a new roll grinder. In June, Alcan reached an agreement to purchase the aluminum and steel siding manufacturing operations of the Alside division of Associated Materials Inc. In August, Alcan's U.S. subsidiary, Alcan Aluminium Corporation announced that it would spend US$20 million to build a new electrical conductor plant in Roseburg, Oregon. The plant is expected to be completed in 1991.

In October, Alcan announced that Logan Aluminum Inc., a company jointly owned with Atlantic Richfield Company (ARCO), would expand its sheet rolling facilities at Russellville, Kentucky. The project, which includes a three-stand high-speed cold mill, an additional coating line, a high-speed precision slitting line, two ingot preheat furnaces, an ingot scalper and new material handling equipment, is expected to cost US$280 million and be completed by the end of 1992. The expansion, except for the preheat furnaces, will be financed and owned by Alcan. An additional US$170 million expansion in the mid-1990s is also being considered for the Russellville facility. This would include adding a fourth stand to the hot rolling line and another cold rolling mill.

It was reported in November that Alcan had purchased Technical Ceramics Laboratories Inc., a company involved with injection moulding of ceramics, metals, carbides and composites. Also in November, Alcan announced that its Luxfer USA Ltd. subsidiary would build a US$15 million plant in Graham, North Carolina that will produce aluminum high-pressure gas cylinders. In the same month, Alcan opened a new 120 000 t/y beverage scrap recycling plant at Berea, Kentucky.

Also during 1989 in the United States, VAW of America Inc. purchased Easco Corp.'s aluminum extrusion plant in Phoenix, Arizona in January, and Columbia Aluminum Corp. purchased an idle aluminum extrusion plant in Rockwall, Texas from Alumax Inc. Columbia announced that the plant, which would operate under the name of Columbia Extrusion Corp., would be re-activated immediately. In February, Columbia purchased an extrusion plant and an extrusion fabricating plant in California from Indal Limited of Canada as well as the extrusion business of Pacific Aluminum Corp., also in California.

In April, it was reported that Secondary Aluminum Smelters Inc. would complete a new 16 000 t/y secondary smelter in Chattanooga, Tennessee, in June. Also in April, it was reported that a Japanese consortium would build a new secondary facility in Columbus, Indiana, with an annual capacity of 7200 t, while Reynolds Metals announced that it would invest US$47 million to expand production at its carbon plant in Lake Charles, Louisiana.

Golden Aluminum Company, a subsidiary of Adolph Coors Company, announced plans in May 1989 to build a US$50 million aluminum rolling mill in San Antonio, Texas. It is expected that the plant will have a capacity of about 115 000 t/y of aluminum can stock.

Reynolds Metals announced in August that it would spend US$50 million over the next two years to improve efficiency at its alumina plant at Corpus Christi, Texas. Also in August, Ube Industries Ltd. reported that it would build a new aluminum wheel manufacturing plant in Mason, Ohio. The US$60 million facility, with a planned capacity of one million units per annum, is expected to be completed in 1991. In September, Alumax Inc. announced that it had concluded an agreement with Superior Industries International covering the use of Alumax's semi-solid metal technology for the production of aluminum wheels. Should pilot plant testing be successful, a new wheel plant with a capacity of one million wheels per year may be built.

In September, Noranda Inc. agreed to purchase the aluminum rolling division of National Aluminum Corp., a subsidiary of National Intergroup, Inc., for US$117.7 million. The sale included a continuous casting and finishing mill in North Carolina, a cold-rolling conversion mill in Arkansas and a foil laminating mill in Ohio. Also in September, the 32 500 t/y secondary smelter of Southern Alloys Company in Shelbyville, Tennessee ceased production due to a shortage of operating capital. The facility commenced operations in February 1989.

The Bonneville Power Administration (BPA) announced in November that it was implementing a freeze of its base power rates in the Pacific northwest for the next two years. Power rates for aluminum companies in this region combine a fixed base rate of US22 mills/kWh plus an amount calculated on the basis of prevailing aluminum prices. Producers paid a maximum rate of US28.8 mills for the first nine months of 1989, with rates falling thereafter. In December, it was reported that the BPA might be unable to generate sufficient power to meet the requirements of its customers due to continuing dry weather conditions.

Reynolds Metals announced in December that it would spend US$30 million to expand and modernize its aluminum plate production facility in McCook, Illinois, while the company announced in January 1990 that it would invest US$18 million at its Bellwood No. 44 aluminum sheet rolling mill near Richmond, Virginia. Also in January, it was reported that National Southwire Aluminum Co. was contemplating the closure of its 175 000 t/y smelter at Hawesville, Kentucky due to both high alumina and power rates. Under the terms of a variable power rate scheme, the smelter pays a base rate of US32 mills plus 0.7 mills for every 1¢ increase in the price of aluminum over 62¢, to a maximum of 44 mills.

Jamaica

In April, Hydro Aluminium a.s. of Norway completed the purchase of a 35% interest in the Alumina Partners of Jamaica (Alpart) alumina refinery in Jamaica. Kaiser Aluminum & Chemical Corporation, which had jointly owned the plant with Reynolds Metals, increased its share to 65%. The 1.1 Mt/y refinery, which was closed in 1985, was restarted in the second quarter of 1989.

During 1989, it was reported that the Jamaican government was reviving plans to build an aluminum smelter in that country. The smelter would utilize electric power generated from natural gas imported from Trinidad and Tobago. It was also reported that Alcan and the Jamaican government were studying the feasibility of building a new 1 Mt/y alumina refinery on the north coast of the island, while the government and Pechiney were reported to be discussing the expansion of the 800 000 t/y Clarendon refinery to 1.5 Mt/y. The Clarendon plant is jointly owned by the government and Alcoa.

South America

In Guyana, a seven-week strike by workers in the country's bauxite industry during the second quarter of 1989 seriously affected production. The state-owned Guyana Mining Enterprise, Ltd. reported that it hoped to make up the losses during the fourth quarter of the year. During 1989, it was reported that the Government of Guyana was holding discussions with a number of companies, including Reynolds Metals, Hydro Aluminium, Kaiser Aluminum, Alcan and Clarendon Ltd., with regard to the development of that country's bauxite reserves and the reactivation of the idle Linden alumina refinery.

In Surinam, the Suriname Aluminum Company (Suralco), a subsidiary of Alcoa, was forced to close its Moengo bauxite mine on October 30, 1989, because of fighting in the area. While the closure only lasted a few days, operations did not return to normal for some weeks. Earlier in the year, Suralco and Billiton N.V. announced that they planned to develop two new bauxite mines in Surinam.

Despite the continued optimism of Venezuelan aluminum industry officials, little progress was achieved during 1989 in terms of advancing a number of proposed aluminum smelter projects that had been announced in 1988. In February, investor confidence in Venezuela received a serious setback when rioting erupted in the country, killing 300 people. While it was reported later in the year that a construction contract had been signed for the 120 000 t/y Alisa (Aleaciones Ligeras SA) project, the aluminum industry suffered another reversal at the end of the year when a draft plan of the Ministry of Planning recommended that five aluminum smelter projects in which the government planned to participate, including Alisa, be put on hold due to the lack of funds. This moratorium would also apply to bauxite and alumina expansion projects as well as to two new hydro-electric developments. It was also reported that the Government of Venezuela was considering the sale of its aluminum industry investments.

Venezuela's two current aluminum smelter projects, the 118 000 t/y expansion being undertaken by Industria Venezolana de Aluminio CA (VENALUM), and a 90 000 t/y expansion by Aluminio del Caroni SA (Alcasa), were reported to be experiencing serious technical problems.

It was reported in September that a 65 000 t/y secondary aluminum plant was under construction in Venezuela, a joint venture between Corporacion Venezolana de Guayana (CVG) and SMG-Sommer Metallewerke GmbH of West Germany. The facility is expected to be completed in 1991.

In April, workers at the smelter of Valesul Aluminio SA in Brazil occupied the plant between April 18 and 25, 1989 in order to press management for wage increases. Production at the plant during this labour action was maintained, although at a reduced level. Also in April, workers at Alcan's Saramenha smelter staged a two-day work stoppage. No loss of production was reported.

During 1989, work continued on two aluminum smelter projects in Brazil. These include an 83 000 t/y expansion to the Aluminio do Maranhao S.A. (Alumar) smelter which is scheduled to be completed by the end of 1990 and the 160 000 t/y second phase of the Aluminio Brasileiro SA (Albras) project which is expected to be completed by the end of 1991. While negotiations continued on a possible restart of construction on the Alunorte alumina project, there had been no agreement by year-end. It was also reported that a number of companies, including Alcoa, Alcan and Billiton, would participate in a new US$1.2 billion hydro-electric development in northern Brazil.

Australia

It was reported in March 1989 that Austria Metall A.G. had agreed to purchase a 10% stake in Australia's Portland aluminum smelter from the Victorian state government agency, Aluminium Smelters of Victoria Pty Ltd. (Aluvic) for Australian (A) $192 million. However, in October, the company withdrew its offer citing contractual clause difficulties. During 1989, Austria Metall did purchase a 20% interest in the 220 000 t/y Boyne Island smelter from Kaiser Aluminum of the United States. The Boyne Island plant is operated and 30% owned by Comalco Limited with the remaining 50% owned by a Japanese consortium.

In April, workers at Comalco's 128 000 t/y Bell Bay smelter in Tasmania went on strike over a dispute regarding compensation for bearded employees who were forced to shave in order to wear respiratory equipment. During the strike, which lasted about five days, production at the plant was maintained by management and salaried staff.

During 1989, Comalco announced that it was contemplating an expansion at the Boyne Island smelter that would increase capacity to 400 000 t/y. In a move designed to ensure the price and the reliability of power supplies for such an expansion project, the company agreed in principle in September to buy the coal-fired power plant supplying the smelter from the Queensland government for A$500 million. Comalco is also considering a 100 000 t/y expansion to its Tiwai Point smelter in New Zealand if it can agree on appropriate power rates with the government, or the conclusion of other suitable arrangements for the procurement of secure power supplies including the purchase of power generation facilities. During 1989, it was also reported that Tomago Aluminium Co. Pty. Ltd. of Australia was considering a 120 000 t/y expansion of its smelter, at a cost of A$500 million.

In July 1989, a new A$50 million aluminum wheel plant was opened at Bell Bay in Tasmania. The facility is jointly owned by Comalco Limited, the Australian Industry Development Corporation and Enshu Keigon KK and Mitsubishi Corporation of Japan. It was reported that initial output from the plant would be purchased by Nissan of Japan and Bayerische Motorenwerke AG (BMW) of West Germany.

Alcoa of Australia Ltd. announced in October 1989 that it was going ahead with the construction of a second stage at its Wagerup alumina refinery in Western Australia. The US$300 million project will increase alumina capacity at the facility by 630 000 t/y by mid-1992.

Asia

In Japan, Sumitomo Light Metal Industries Ltd. announced during 1989 that it planned to build a new 6000 t/m can-stock line at its Nagoya works. The plant, which is expected to be completed in 1991, will replace older facilities.

Chronic shortages of hard currency, raw materials and electrical power during 1989 continued to plague the aluminum industry in the People's Republic of China. It is believed that the industry fell well short of its target of 840 000 t of aluminum metal for 1989.

In April, Aluvic, the aluminum trading and investment company owned by the Victoria government in Australia, was reported to have withdrawn from a joint venture aluminum rolling mill project in China, worth an estimated A$400 million. In May, it was reported that China National Nonferrous Metal Industry Corporation (CNNC) and the province of Guizhou would build a new 80 000 t/y smelter, near the existing Guizhou plant. The plant is expected to be completed in 1991. Additional projects, including another 80 000 t/y smelter, a 600 000 t/y alumina plant and fabrication facilities, are also planned for the Guizhou site. During 1989, it was also reported that the International Trade and Investment Corporation of China had cancelled a contract to purchase the idled Sakata aluminum smelter from Sumitomo Metal Industries, Ltd. of Japan.

Elsewhere in southeast Asia, it was reported that a new aluminum smelter was being considered for Malaysia, while in South Korea a 100 000 t/y aluminum rolling mill is expected to be built by 1991.

In India, National Aluminium Co. Ltd. (Nalco) plans to undertake a Rs 12 400 million expansion of its integrated aluminum operations in Orissa state. This includes an expansion of bauxite mining and alumina refining operations to 3.6 Mt and 1.0 Mt, respectively. In addition, Nalco will increase the capacity of its Angul smelter by a further 112 000 t/y. This plant's second potline, which experienced considerable delays during its start-up, is expected to be fully commissioned during 1990. It was also reported that Indian Aluminium Co. Ltd. (Indal), 39% owned by Alcan Aluminium Limited, will increase smelting capacity by 30 000 t/y and produce 50 000 t/y of foil by the end of 1990. Also in India, it was reported that Bharat Aluminium Company Limited (BALCO) was forced to close its Gandhamardan Hills bauxite project because of environmental opposition from the local population.

In December, it was reported that the U.S.S.R. had agreed to supply Iran with machinery and technology to produce alumina from nepheline syenite.

During 1989, planning continued on several new aluminum smelter projects in the Middle East. In May, the Government of Bahrain gave the go-ahead for a 235 000 t/y expansion to the smelter of Aluminium Bahrain B.S.C. This US$1.3 billion project is in addition to a current modernization project at the plant which will increase capacity from 200 000 t/y to 225 000 t/y. Aluminium Bahrain is owned 74.9% by the Government of Bahrain with the remainder held by the Saudi Arabian Investment Fund and Breton Investments of West Germany. Kaiser Aluminum, which had held a 17% interest in the plant, sold its stake to the government during 1989 for US$72.8 million.

In Saudi Arabia, a new 214 000 t/y smelter at Yanbu, on the Red Sea, is also being planned. Potential participants in the US$800 million Alusa smelter project include Alujain Corp. of Saudi Arabia, Alumix, part of the Ente Partecipazioni e Finanziamento Industria Manifatturiera group of Italy, Pechiney of France and British Aerospace. The smelter is expected to come on-stream in 1992. During 1989, it was reported that Dubai Aluminium Company Limited (Dubal) was proceeding with an expansion which will increase its smelter capacity from 170 000 t/y to 235 000 t/y by March 1991. It was also reported that a new 215 000 t/y smelter would be built in Iraq.

In Qatar, another smelter with a capacity of 193 000 t/y at a cost of US$1.25 billion is also being considered. The project, which also includes a 500 MW power station, is scheduled for completion in 1993. Participants in the smelter include Amari plc of the United Kingdom, a group of U.S. fabricators and China National Metals and Minerals Import and Export Corporation.

Elsewhere in the Middle East, Kuwait announced its intention to build a US$60 million plant to produce calcined coke for Gulf aluminum smelters.

Africa

In June 1989, it was reported that Hydro Aluminium had purchased a 20% interest in Frialco, which in turn owns 51% of the Guinean alumina producer, Ste Friguia. The remaining 80% of Frialco is owned by Pechiney (30%), Noranda (30%) and Alcan (20%).

It was announced in August that General Mining Union Corporation Limited (Gencor) had purchased a 30.7% interest in Alusaf (Pty.) Ltd. in the Republic of South Africa. Alusuisse owns 23% of Alusaf, while the Development Corporation of South Africa controls most of the remainder.

In November, it was reported that a new 220 000 t/y aluminum smelter would be built in Algeria. Participants in the $1 billion project include the Algerian Public National Enterprise and the Industrial Development Corp. of Dubai. The project is expected to be completed by late 1992 or early 1993.

Europe

Alcan announced in February that it would spend £6 million to upgrade and modernize its foil rolling mills in Glasgow. In April, the company announced that it would build Europe's first beverage can recycling plant at Latchford Locks in the United Kingdom. The £20 million facility, which is expected to be completed in 1991, will have a capacity of 50 000 t/y.

In February, Hydro Aluminium announced that it was building a 6500 t/y aluminum extrusion plant near Ulm in West Germany at a cost of Nkr 60 million.

In Greece, a lock-out of management personnel at the smelter and alumina refinery of Aluminium de Grèce S.A between February 25, 1989 and April 17, 1989, forced the company to declare "force majeure" on aluminum and alumina shipments. While workers continued to operate both facilities, alumina production was reduced and aluminum metal output was poured into pits. It was also reported that the aluminum smelter sustained some damage during the strike. Aluminium de Grèce is 60% owned by Pechiney of France. Elsewhere in the country, work continued on the new 600 000 t/y alumina refinery, a joint venture between the Greek government and the U.S.S.R. The project, which is now expected to be completed in the second half of 1992, has experienced a number of delays due to financing difficulties.

It was announced in September that Clarendon Ltd. was purchasing an 18% interest in the Sardinian alumina producer Eurallumina S.p.A. Comalco Limited's share will fall from 37.5% to 29.9% while Aluminia SpA will reduce its stake to 52.1%.

On April 10, workers at Pechiney's 120 000 t/y St. Jean de Maurienne smelter in France locked management out of the plant but continued to operate the facility. The strike ended on April 21. Also in April, there was a short strike at British Alcan Lynemouth Limited's smelter in the United Kingdom during which management maintained production.

During 1989, Pechiney commenced construction of a 214 000 t/y smelter at Dunkirk, in northern France. The plant, which will cost 5 billion francs, is expected to come on-stream in early 1992. In October, the European Commission gave the go-ahead for the project after investigating a complaint by British Steel Plc that Electricité de France, a partner in the project, would supply power at unfairly cheap rates. However, the ruling is subject to the condition that power rates increase by an annual rate of 10% during the years 1997 to 1999. Also in October, Pechiney announced that it would spend 560 million francs to increase capacity at its aluminum sheet mill at Neuf-Brisach by 85 000 t/y. In December, it was reported that the company planned to build a plant at Nogueres to produce beverage can ends. Also in December, the company announced that it had signed a declaration of intent to build a plant to manufacture flexible aluminum tubes in the Democratic Republic of Germany.

In December 1989, it was reported that Sor-Norge Aluminium A/S of Norway, a joint venture between Alusuisse and Hydro Aluminium, would increase its smelting capacity from 68 000 t/y to 100 000 t/y.

At the end of 1989, both Alusuisse and Austria Metall announced that they were withdrawing from the 200 000 t/y Atlantal smelter project in Iceland. The remaining partners in the project are Hoogovens, Granges Aluminium AB and the Icelandic government.

During 1989, the U.S.S.R. entered into a number of joint venture aluminum projects with western companies in an effort to increase the size and efficiency of its aluminum industry as well as the diversity of aluminum products. These included the Interplav joint venture with Remetal of Spain to produce aluminum alloys at a factory in Sverdosk, an agreement with Reynolds Metals and the Fata European Group of Italy to build a US$200 million foil production and converting plant at Sajanogordak in Siberia, plus a joint venture with International Engineering Consultants (U.K.) Ltd. and Kaiser Aluminum & Chemical Corporation of the United States to design, build and operate a new smelter and modernize an old smelter at Irkutsk in Siberia. In addition, there were reports of discussions with Pechiney for a can sheet plant in Moldavia, an aluminum smelter at Sainsk in Siberia, a packaging plant in Armenia, and a flexible aluminum tube mill in Kazakhstan.

RECYCLING

The production of secondary aluminum in the market economy countries during 1989, excluding the direct use of scrap, was estimated at about 5.0 Mt, equal to the record amount produced in 1988. This compares to 4.5 Mt in 1987 and 4.0 Mt in 1985. The recent increase of secondary production is due primarily to the impact of sharply higher prices for primary aluminum and, to some degree, from continuing improvements in the scrap collection system and increased recycling promotion by governments and environmental groups. From both a commercial and environmental perspective, additional increases in aluminum recycling are supported by the fact that recycling requires less than 5% of the energy used to make the original metal.

In 1988, the largest secondary producers were the United States at 1.859 Mt, Japan with 1.309 Mt, West Germany at 0.531 Mt, Italy at 0.378 Mt and France at 0.211 Mt. Canadian production in 1988 was 113 000 t compared to approximately 68 000 t in 1987.

The most important sources of aluminum scrap in the United States are from the packaging (principally used beverage containers) and transportation sectors. During 1988, the Can Manufacturers Institute in the United States reported that 42.5 billion cans were recycled in that country, up from 37 billion in 1987. This represents a recycling rate of 54.6% and a total tonnage of almost 700 000 t.

CONSUMPTION AND USES

Western world consumption of primary aluminum in 1989 is expected to reach 14.65 Mt, an increase of about 1.2% over 1988.

Aluminum is a ductile, non-magnetic, silvery white metal, with a density only one-third that of steel. While pure aluminum has a relatively low tensile strength, this can be improved by alloying and appropriate thermal and mechanical treatment. In addition, aluminum has a high degree of corrosion resistance and is an excellent conductor of heat and electricity as well as a good reflector of light and radiant heat. Aluminum can be fabricated by all known metal-working processes. The metal can be joined by welding, brazing, soldering, adhesive bonding, rivetting, stitching and stapling, and will accept a wide variety of mechanical and chemical finishes.

The metal, in alloyed and unalloyed forms, is suitable for use in a wide variety of products for both the consumer and capital goods markets. The largest markets for aluminum in terms of total consumption are transportation (27%), building and construction (20%), packaging (20%), electrical (9%), consumer durables (7%), and machinery and equipment (7%).

The transportation sector, the largest single market for aluminum worldwide, can be broken down into a variety of sub-markets. These include the manufacture of automobiles, buses, trucks, trailers, ships, railroad and subway rolling stock as well as in aerospace applications and mobile homes. In recent years, aluminum has made significant inroads into the automobile parts manufacturing industry at the expense of steel/cast iron and copper/brass. Important applications include wheels, radiators, automotive air conditioning units, engine heads and blocks, intake manifolds, pistons, transmission housings and other power train parts. It is expected that the average North American automobile in 1990 will contain 176 lb. of aluminum, representing 5% of the average total weight of a car, increasing to almost 200 lb. by the year 2000. This compares to 81 lb. in 1973 which represented only 2% of gross vehicle weight. The principal reasons for this increase are related to general weight and size reductions of automobiles in order to improve fuel efficiency and also to the unique weight distribution requirements of front-wheel-drive vehicles. With further toughening of fuel economy standards, it is expected that aluminum use in automobile applications will continue to grow.

A potential new application for aluminum in the automotive industry is in the production of car bodies. There are several different variations of this technology, including Alcan's Aluminum Structural Vehicle Technology (ASVT) process which utilizes adhesively bonded sheet aluminum. Alcan claims that its ASVT structure offers a 50% weight reduction over steel with equal stiffness, equal strength and crashworthiness. In December 1989, Alcan announced that Jaguar would use the ASVT technology in the production of about 300 XJ220 super-cars. In addition, Honda Motor Co. Ltd. plans a limited run of 5000 of its new, all-aluminum NS-X sports cars.

While aluminum faces intense competition from titanium and a new generation of polymer, ceramic and composite materials that are lighter and stronger than conventional aluminum alloys, the metal remains the principal structural material in the aircraft industry. In 1989, consumption of aluminum for aircraft/aerospace applications in the United States was estimated at over 240 000 t or approximately 16% of transport sector shipments. Despite the competitive threat from new materials, a number of the composites are aluminum-based such as silicon carbide fibre aluminum or silicon carbide whisker aluminum. As such, aluminum's future in the aviation/aerospace industry would seem assured.

In response to the changing needs of aircraft manufacturers and, undoubtedly, to breakthroughs in the development of substitute materials, the aluminum industry has expended considerable effort to develop and market new aluminum-lithium alloys. These offer weight savings of up to 15% in new design applications without requiring changes to tooling or fabrication techniques. In future, it is expected that new aluminum-iron-cerium and aluminum-scandium alloys, as well as aluminum laminates will also find application in this industry.

In the railroad equipment industry, Alcan Aluminium Limited, through a joint venture with Thrall Car Manufacturing Co., has developed a new coal car that can carry 20 000 lbs. more than a conventional steel car. While more expensive to purchase, the user is more than compensated through operating savings of 8 to 10% and lower maintenance costs. In the case of subway cars, it is estimated that the difference in cost is made up in as little as 1.5 to 2 years.

In addition to the advantages of aluminum in railroad rolling stock in terms of lower operating costs, rail passenger equipment manufacturers can utilize the metal to build high-speed trains that can compete effectively with aircraft for short- to medium-haul travel. In Japan, a new high-speed train under development in which cars will be magnetically levitated using linear induction motors will likely utilize aluminum to reduce weight.

Within the building and construction sector, major aluminum uses include residential siding, roofing, eavestroughs, windows, doors, frames, screens, awnings and canopies. Within this sector, aluminum faces intense competition from vinyl, particularly in the siding market and from wood in framing applications. A new fire-resistant building panel developed by Reynolds Metals Company could provide aluminum with significant new growth opportunities in building and construction. The product, known as Reynobond consists of a thermoplastic compound plastic core between two sheets of aluminum. In addition to its fire resistance, this lightweight panel has been designed to maintain flatness and to offer durability in different weather extremes.

Unlike the other uses in which consumption is fairly evenly distributed between regions, the United States dominates the containers and packaging sector with over 75% of the total. Within this broad market classification, the major uses of aluminum are for foil, flexible packaging, beverage and food containers, other cans and closures. The largest single segment of this market is aluminum beverage cans. Can shipments in the United States during 1989 were estimated at 82.7 billion units and are expected to surpass 86 billion units in 1990. While aluminum has dominated, and continues to dominate, the U.S. beverage industry with over 95% of the market, there has been renewed interest in steel in recent years. This was particularly true in 1988 when aluminum achieved record highs. However, with a return to lower prices during the second half of 1989, the potential advantages from substitution had largely disappeared. Although aluminum has often been a somewhat more expensive packaging material than steel for beverage can applications, the metal does benefit from long-standing consumer acceptance and a good record as a recyclable material.

The food can market, which in the United States accounts for about 28 billion containers per year in total, has been targeted by the aluminum industry as an area for future growth. At present, aluminum's share of the U.S. market is about 10%, which in itself represents a 100% increase over the last five years.

Much of aluminum's success to date has been with shallow-drawn cans, and particularly with cat food cans. Unlike the beverage can market, which in North America is dominated by the 12-ounce container, the food can market is characterized by a diversity of container sizes and a multitude of different packaging requirements. While the industry has solved certain problems associated with aluminum usage for larger food containers such as low internal strength through the nitrogen-injection process, development work for some applications is still ongoing.

In January 1990, it was announced that Reynolds Metals had signed a long-term contract with Campbell Soup Company to eventually supply all of Campbell's juice can requirements, including both 5.5 and 11.5 ounce container sizes.

Moreover, should consumers continue to demand the convenience of more microwavable packaging, opportunities for growth of aluminum usage in this application may be limited. However, in view of aluminum's recyclability combined with growing concern regarding the disposal of garbage, the metal may well benefit from the enactment of new legislation covering the choice of packaging materials.

In the electrical field, aluminum extensively replaced copper in wiring and power transmission in the 1960s but, while it has maintained the market for power transmission applications, local restrictions and consumer resistance have substantially lessened the demand for aluminum in electrical wiring. Aluminum has, however, gained acceptance in various communications and computer applications. While there have been some gains for aluminum in electrical applications both in Japan and in Europe, overall consumption has remained fairly constant due to slumping demand in the United States.

Some of the most promising new applications for aluminum are based on a family of new metal matrices. One example developed by Alcan is "Duralcan" which is aluminum reinforced with silicone carbide ceramic particles. While outperforming traditional aluminum alloys, it can be fabricated with the same techniques. It also has greater specific strength and is lighter than steel and less expensive than titanium. Initial markets for this material are expected in sporting goods, cast products and small engine components. Potential applications are also expected in the automotive and aerospace industries.

A promising new use for the metal is in the new aluminum air-cell battery that has been developed by Alcan. The main advantages of the battery are long shelf life, low weight before activation and constant power output. One of the many potential uses for the battery is in electric vehicles. When used in combination with a conventional lead-acid battery, the range of an electric vehicle increases from approximately 75 km to over 300 km.

TARIFFS AND TRADE

During 1989, it was reported that the issue of the European Communities' 6% import tariff on aluminum could be resolved in the course of continuing talks of the Uruguay round of GATT negotiations. With a growing reliance on imported aluminum, it was also reported that there is growing opposition within the EC to the maintenance of tariff protection.

As part of forthcoming discussions with the Gulf Cooperation Council on the establishment of freer trade between the EC and the Gulf countries, the EC, according to press reports, was considering a proposal to gradually phase out tariff protection against aluminum from this region. Initially, 20 000 to 25 000 t/y of Gulf aluminum would be exempted from import duties, with the amount increasing to 100% by 1996.

Under a provision of the Canada-U.S. Free Trade Agreement, under which companies can request faster tariff elimination than originally provided, a number of tariffs covering aluminum products will be eliminated on April 1, 1990. These include several aluminum wire and powder products as well as plate, sheet or strip, aluminum alloy, rectangular or square, exceeding 0.2 mm thick.

MARKETS, PRICES AND STOCKS

During 1989, there was a significant erosion of aluminum prices with the London Metal Exchange (LME) price for high-grade aluminum (99.7%) averaging US88.5¢/lb. as compared to $1.17 in 1988. From an average price of $1.09 in January, prices declined through the first half of 1989 to 86.8¢ in June. Despite slight recoveries in August and October, the downward trend continued in the second half of the year with the price in December averaging 74.1¢. Aluminum continued to weaken in January 1990, with prices falling to 62.6¢ at month-end.

While spot alumina prices at the end of 1989 had dropped to a range of between US$450 and $500/t from levels in excess of US$700/t at the end of 1988, there was a significant escalation of one-year and two-year contract prices. Two-year contract prices at the end of 1989 were reported to be about $350/t, an increase of between $75 and $100 from 1988, while one-year contract prices were quoted at between US$375 and $400/t.

In July 1989, the LME established 62 Japanese warehouses as good delivery points for LME-traded primary aluminum. In addition to other existing warehouses in Singapore and Europe, the LME is continuing to explore the possibility of opening new warehouses in the United States.

The International Primary Aluminum Institute (IPAI) reported that total inventories of aluminum (including primary and secondary ingot, remelt ingot, foundry ingot, remelt scrap ingot, sheet ingot, extrusion billet, wire bar and cast rod) in December 1989 stood at 3.207 Mt compared to 3.268 Mt in September and 3.085 Mt in December 1988. According to the IPAI, primary metal stocks in December 1989 were 1.568 Mt compared to 1.592 Mt in September and 1.482 Mt a year earlier.

HEALTH, SAFETY AND ENVIRONMENT

Alzheimer's disease is a degenerative condition affecting the brain, the cause of which is not known. However, there have been suggestions that aluminum and/or aluminum compounds may play a role in the development of this disease. In this regard, early studies reported that Alzheimer sufferers had a higher-than-normal concentration of aluminum in their brain tissue. In addition, the injection of aluminum salts into the brains of laboratory animals was reported to produce lesions in the brain.

However, more recent research has revealed that the aluminum-induced lesions are quite different, both chemically and structurally, from the lesions found in diseased human brains. In addition, it has been found that aluminum levels in the brain increase slightly with the aging process but not necessarily in association with the progression of Alzheimer's disease. Exhaustive research on both the affects of aluminum in the body and Alzheimer's disease is continuing.

Aside from the possible health hazards of aluminum use, there are several environmental issues pertaining to the production of both alumina and aluminum.

The waste product from the processing of bauxite to alumina (Bayer process), an alkaline residue known as red mud, presents a significant problem because of its toxicity and the large volume of production (estimated at 40 Mt/y of solids worldwide). While the construction of sealed impoundment areas has been an effective method for dealing with this problem, it is relatively expensive and space intensive - space that will be unsuitable for any other use. In response to this problem, the industry has developed various dry-stacking techniques, which are useful both in terms of reducing the land requirements for a specific volume of waste material and most importantly for permitting the utilization of the land for purposes such as agriculture at some future date. An alternative method of disposal, and one which the industry is deeply involved in, is the development of uses for red mud. One of the most promising applications is in the production of concrete products.

A more serious environmental issue for the aluminum industry relates to the emission of fluorides from the Hall-Heroult smelting process. For older smelters which utilize Soderburg technology, the production of polycyclic aromatic hydrocarbons (PAHs), which are suspected cancer-causing agents, is another serious concern.

As stated earlier in this report, Alcan is building a new smelter at Laterrière, Quebec which, when commissioned, will replace most of the company's Soderburg potlines at Jonquière. The latest generation of aluminum smelters including Laterrière utilizes a pre-baked anode which largely eliminates harmful emissions of PAHs. Moreover, newer smelters incorporate fume collection systems that utilize scrubbers to remove most fluorides.

As governments, particularly in the United States and Europe, move to reduce emissions of sulphur dioxides and nitrogen oxides from coal-fired electric generating stations, power costs to many aluminum smelters are expected to rise significantly. In the United States, it is estimated that electricity costs for the industry could increase from US$94 million to $150 million as a result of the introduction of acid rain legislation. For producers in the east-central part of the country, smelting costs could increase by as much as US7.7¢/lb.

In December 1989, Alcan announced the development of a new technology to recycle aluminum dross in which the salt fluxes used in the conventional process are eliminated. The process, which breaks down the dross into aluminum and other usable products, is expected to alleviate the problems associated with the disposal of wastes at landfill sites. In addition, the technology utilizes a plasma arc gas heater which diminishes and simplifies the treatment of gaseous emissions.

OUTLOOK

Despite signs that overall aluminum demand was weakening somewhat at the end of 1989, particularly in North America, it is expected that aluminum's underlying strength will be maintained in 1990. Although the downward trend of prices may continue during the first part of the year, it is expected that the market will show some recovery in the second half. For the year as a whole, prices are forecast to average US75¢/lb.

Aluminum demand, which will continue to depend largely on traditional markets, particularly packaging, transportation and construction, is forecast to grow at an average annual rate of about 1.5% during the period 1990 to 2000. The bulk of this growth is expected to be in the newly industrializing countries such as India, Brazil, Mexico, Venezuela, South Korea and Taiwan.

While some expansion of the world's primary smelting capacity is required to meet the expected increase of aluminum demand, the completion of a number of smelter projects, beginning in 1991, is expected to have a dampening effect on prices in the short term. However, in view of the fact that some of these projects, such as those being considered for Venezuela, may be delayed for reasons associated with political risk or price uncertainty, the forecasted oversupply may be smaller than originally anticipated. It is expected that aluminum prices in the next decade will average between US69¢/lb. and 77¢/lb.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
76.01	Unwrought aluminum				
7601.10	- Aluminum, not alloyed				
7601.10.10	--- Billets, blocks, ingots, notched bars, pigs, slabs and wire bars	Free	Free	Free	Free
	--- Other				
7601.10.91	---- Granules, cut from ingots, for use in the manufacture of cleaning compounds	1.98¢/kg	Free	Free	Free
7601.10.99	---- Other	10.3%	6.5%	Free	Free
7601.20	- Aluminum alloys				
7601.20.10	--- Billets, blocks, ingots, notched bars, pigs, slabs and wire bars	Free	Free	Free	Free
	--- Other				
7601.20.91	---- Granules, cut from ingots, for use in the manufacture of cleaning compounds	1.98¢/kg	Free	Free	Free
7601.20.99	---- Other	10.3%	6.5%	Free	Free
7602.00.00	Aluminum waste and scrap	Free	Free	Free	Free
76.03	Aluminum powders and flakes	9.2 to 10.3%	Free to 6.5%	5.5 to 6.1%	3.1 to 4.5%
76.04	Aluminum bars, rods and profiles	2.1 to 10.3%	Free to 6.5%	1.2 to 6.1%	1.2 to 4%
76.05	Aluminum wire	2.1 to 10.3%	Free to 6.5%	1.2 to 6.1%	2 to 3.3%
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	Free to 10.3%	Free to 6.5%	Free to 8.2%	Free to 5.8%
76.07	Aluminum foil not exceeding 0.2 mm	Free to 12.2%	Free to 8%	Free to 9.7%	2.7 to 5.2%
76.08	Aluminum tubes and pipes	8.1%	Free	4.8%	4.5%
76.09	Aluminum tube or pipe fittings	10.3%	6.5%	8.2%	5.1%

76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	10.3%	6.5%	8.2%	5.1%
7611.00	Aluminum reservoirs, tanks, vats and similar containers	Free to 10.3%	Free to 6.5%	Free to 8.2%	2.3%
76.12	Aluminum casks, drums, cans, boxes and similar containers	10.3%	6.5%	8.2%	2.1 to 5.1%
7613.00.00	Aluminum containers for compressed or liquefied gas	10.3%	6.5%	8.2%	4.5%
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	10.2%	6.5%	8.1%	4.4 to 5.1%
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	10.2 to 11.4%	Free to 6.5%	8.1% to 9.1%	3.4 to 5.1%
76.16	Other articles of aluminum	Free to 10.3%	Free to 6.5%	Free to 8.2%	4.2 to 5.6%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, ALUMINUM PRODUCTION AND TRADE, 1988 AND 1989p

Item No.		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production		1 534 499	. .	1 554 753	. .
Imports				(Jan.-Sept.)	
2606.00.00	Aluminum ores and concentrates				
	Brazil	1 335 561	48 139	887 961	31 955
	Guinea	341 511	14 620	261 366	11 098
	Sierra Leone	287 531	10 592	242 752	9 728
	Guyana	66 527	3 740	184 588	8 068
	United States	105 033	20 569	31 562	7 605
	Other countries	215 432	12 269	215 590	10 162
	Total	2 351 595	109 929	1 823 819	78 616
2620.40.00	Ash and residues containing mainly aluminum	1 816	2 347	767	674
2818.20.00	Aluminum oxide (excluding artificial corundum)				
	United States	449 543	102 786	708 819	211 908
	Jamaica	507 816	132 840	401 518	127 897
	Australia	777 185	171 372	363 847	102 064
	Japan	42 289	12 257	52 464	14 324
	France	2 425	2 179	1 897	1 980
	West Germany	185	302	154	495
	United Kingdom	316	320	157	270
	Other countries	86 828	22 699	318	272
	Total	1 866 587	444 755	1 529 174	459 210
2818.30.00	Aluminum hydroxide	8 959	6 923	7 481	5 590
76.01	Unwrought aluminum				
7601.10	- Aluminum, not alloyed				
7601.10.10	---Billets, blocks, ingots, notched bars, pigs, slabs and wire bars				
	United States	18 938	50 971	9 792	26 469
	France	–	–	619	2 088
	Norway	180	616	203	792
	Brazil	1 661	5 017	42	124
	Other countries	1 895	5 199	15	54
	Total	22 674	61 803	10 671	29 527
7601.10.91	---- Granules, cut from ingots, for use in the manufacture of cleaning compounds	31	95	23	68
7601.10.99	---- Other	1 279	6 045	2 075	5 841
7601.20	- Aluminum alloys				
7601.20.10	---Billets, blocks, ingots, notched bars, pigs, slabs and wire bars				
	United States	33 192	79 417	31 302	80 793
	Brazil	802	2 418	1 087	3 347
	United Kingdom	424	2 079	337	1 448
	Norway	19	287	47	148
	Other countries	792	1 988	78	221
	Total	35 228	86 189	32 851	85 957

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989P	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
7601.20.91	---- Granules, cut from ingots, for use in the manufacture of cleaning compounds	...	...	–	–
7601.20.99	---- Other	178	377	613	1 547
7602.00.00	Aluminum waste and scrap	62 201	90 914	45 423	74 883
76.03	Aluminum powders and flakes	2 947	8 275	1 677	5 877
76.04	Aluminum bars, rods and profiles				
7604.10	- Of aluminum, not alloyed				
	United States	8 386	31 209	7 017	29 361
	Switzerland	112	535	445	1 795
	Other countries	1 129	4 641	400	1 958
	Total	9 627	36 385	7 862	33 114
	- Of aluminum alloys				
7604.21 to	United States	7 918	34 006	7 991	34 978
7604.29	Other countries	961	4 100	773	3 452
	Total	8 879	38 106	8 764	38 430
76.05	Aluminum wire	4 396	14 722	2 345	8 884
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	243 587	794 446	224 595	754 610
76.07	Aluminum foil not exceeding 0.2 mm	34 312	107 630	17 766	76 446
76.08	Aluminum tubes and pipes	6 915	28 774	5 042	23 821
76.09	Aluminum tube or pipe fittings	. .	9 538	. .	6 742
		(number 000)		(number 000)	
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	. .	38 671	. .	38 559
76.11	Aluminum reservoirs, tanks, vats and similar containers	6	795	. . .	142
76.12	Aluminum casks, drums, cans, boxes and similar containers	58 633	19 883	191 412	21 964
76.13	Aluminum containers for compressed or liquefied gas	1 826	1 836	52	3 426
		(tonnes)		(tonnes)	
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	546	807	284	804

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	. .	26 832	. .	22 672
76.16	Other articles of aluminum	. .	140 771	. .	95 556
Exports					
2606.00	Aluminum ores and concentrates				
	United States	1 958	565	2 511	2 371
	West Germany	38	24	–	–
	Japan	17	13	–	–
	East Germany	19	11	–	–
	Total	2 032	614	2 511	2 371
2620.40	Ash and residues containing mainly aluminum	1 256	668	3 891	2 244
76.01	Unwrought aluminum				
7601.10	- Aluminum, not alloyed				
	United States	440 503	1 173 458	259 681	671 479
	Japan	66 739	149 338	60 239	134 439
	South Korea	31 940	90 499	30 889	79 966
	France	719	935	22 658	56 241
	Netherlands	27 045	75 322	14 945	37 808
	Other countries	92 700	247 403	54 326	141 399
	Total	659 646	1 736 955	442 738	1 121 332
7601.20	- Aluminum alloys				
	United States	365 409	990 457	348 481	904 675
	Japan	58 553	154 871	44 606	106 115
	Netherlands	14 751	34 299	12 757	29 949
	Turkey	5 544	14 653	4 259	12 545
	Israel	5 585	16 012	3 743	11 316
	Hong Kong	2 526	7 638	3 708	10 399
	Other countries	42 627	114 306	14 261	40 244
	Total	494 995	1 332 236	431 815	1 115 243
7602.00	Aluminum waste and scrap				
	United States	137 818	251 157	103 764	213 910
	Japan	17 832	36 002	11 557	22 556
	United Kingdom	3 698	8 113	1 783	3 332
	Taiwan	2 001	1 922	1 943	2 416
	Other countries	3 104	6 846	3 774	7 278
	Total	164 453	304 040	122 821	249 492
76.03	Aluminum powders and flakes	299	943	621	967
76.04	Aluminum bars, rods and profiles	3 932	10 521	1 878	7 215
76.05	Aluminum wire	11 537	34 573	11 881	37 377
76.06	Aluminum plates, sheets and strip, of a thickness exceeding 0.2 mm	107 605	309 985	106 023	320 630

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
76.07	Aluminum foil not exceeding 0.2 mm	8 123	25 464	2 816	15 521
76.08	Aluminum tubes and pipes	1 469	4 896	372	1 338
7609.00	Aluminum tube or pipe fittings	. .	2 511	. .	1 805
76.10	Aluminum structures (excluding prefabricated buildings of heading No. 94.06) and parts of structures, aluminum plates, rods, profiles, tubes and the like, prepared for use in structures	. .	40 246	. .	21 694
		(number 000)		(number 000)	
7611.00	Aluminum reservoirs, tanks, vats and similar containers	70	2 067	210	3 512
76.12	Aluminum casks, drums, cans, boxes and similar containers	113 429	19 674	121 886	22 563
7613.00	Aluminum containers for compressed or liquefied gas	2 643	1 749	1 266	873
		(tonnes)		(tonnes)	
76.14	Stranded wire, cables, plaited bands and the like, of aluminum, not electrically insulated	10 498	29 520	1 381	3 646
76.15	Table, kitchen or other household articles and parts thereof, of aluminum	. .	1 666	. .	4 359
76.16	Other articles of aluminum	. .	76 411	. .	47 945

Sources: Energy, Mines and Resources Canada; Statistics Canada.
^{p} Preliminary; . . Not available or not applicable; . . . Amount too small to be expressed; – Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, ALUMINUM SMELTER CAPACITY

Company	as of December 31, 1989
	(tonnes/year)
Alcan Aluminium Limited	
Quebec	
Grande Baie	171 000
Jonquière	358 000
Isle-Maligne	73 000
Shawinigan	84 000
Beauharnois	47 000
Laterrière	50 000
British Columbia	
Kitimat	268 000
Total Alcan capacity	1 051 000
Canadian Reynolds Metals Company, Limited	
Quebec	
Baie Comeau	279 000
Aluminèrie de Bécancour Inc.	
Quebec	
Bécancour	240 000
Total Canadian capacity	1 570 000

Source: Energy, Mines and Resources Canada.

TABLE 3. CANADA, CONSUMPTION[1] OF ALUMINUM METAL AT FIRST PROCESSING STAGE, 1986-88

	1986	1987	1988p[4]
		(tonnes)	
Castings			
Sand	2 000	2 168	2 367
Permanent mould	16 306	19 799	23 249
Die and other	35 122	36 059	52 217
Total	53 428	58 026	77 833
Wrought products			
Extrusions, including tubing	114 374	110 174	146 611
Sheet, plate, coil and foil	153 201	170 949	153 877
Other wrought products (including rod, forgings and slugs)	52 219	56 157	75 637
Total	319 794	337 280	376 125
Other uses			
Destructive uses (deoxidizer), non-aluminum base alloys, powder and paste and other uses	20 048	26 086	34 139
Total consumed	393 270	421 392	488 097
Secondary aluminum[2]	58 338	67 838	113 131

	Metal Entering Plant			On Hand December 31		
	1986	1987	1988p	1986	1987	1988p
Primary aluminum ingot and alloys	339 084	371 604	445 811	19 440	20 048	33 318
Secondary aluminum	46 628	45 691	54 427	2 649	3 149	4 256
Scrap originating outside plant	86 994	99 181	137 101	6 858	6 957	10 128
Total	472 706	516 476	637 339	28 947	30 154	47 702
Aluminum shipments[3]				25 344	26 039	26 795

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[1] Available data as reported by consumers. [2] Aluminum metal used in the production of secondary aluminum is not included in consumption totals. [3] Aluminum metal shipped without change. Does not refer to shipments of goods of own manufacture. [4] Increase in number of companies being surveyed. Therefore, 1987 closing inventory does not equal 1988 opening inventory.

p Preliminary.

TABLE 4. AVERAGE PRICES

Year	Month	LME Cash[1]	LME 3-month[1]	LME Cash[2]	M.W. U.S. Markets[1]
			(USc lb.)		
1979	Average	n.a.	n.a.	72.7	70.7
1980	Average	n.a.	n.a.	80.7	76.1
1981	Average	n.a	n.a	57.3	59.8
1982	Average	n.a.	n.a.	45.0	46.8
1983	Average	n.a.	n.a.	65.3	68.3
1984	Average	n.a.	n.a.	56.5	61.1
1985	Average	n.a.	n.a	47.9	48.8
1986	Average	n.a.	n.a.	52.2	55.9
1987	January	n.a.	n.a	53.1	54.6
	February	n.a.	n.a.	58.2	59.4
	March	n.a.	n.a.	62.0	62.5
	April	n.a.	n.a.	63.5	65.0
	May	n.a.	n.a.	64.0	68.9
	June	n.a.	70.9	66.8	72.5
	July	n.a.	73.5	75.0	74.2
	August	n.a.	77.4	82.1	81.7
	September	80.7	77.4	79.2	80.7
	October	89.1	83.5	89.0	84.4
	November	76.7	74.9	76.2	80.2
	December	83.3	80.3	82.7	83.4
1988	January	91.2	86.0	90.8	89.7
	February	98.2	91.4	97.0	96.3
	March	114.6	103.5	114.6	107.1
	April	113.8	101.6	113.8	107.1
	May	137.0	109.5	135.5	114.5
	June	164.8	129.5	162.3	126.3
	July	122.6	118.2	117.1	122.3
	August	125.2	122.6	122.5	124.4
	September	109.8	108.5	108.3	111.4
	October	106.5	101.5	104.8	104.7
	November	110.4	106.0	108.0	107.4
	December	113.5	109.7	n.a.	110.0
1989	January	108.7	106.9	n.a.	107.7
	February	99.0	98.2	n.a.	99.6
	March	94.0	93.1	n.a.	95.8
	April	96.4	94.0	n.a.	96.4
	May	102.5	95.6	n.a.	97.8
	June	86.8	84.4	n.a.	87.7
	July	79.6	79.0	n.a.	80.4
	August	81.6	81.3	n.a.	81.4
	September	77.9	77.8	n.a.	78.3
	October	82.5	80.2	n.a	79.8
	November	78.7	77.8	n.a.	75.8
	December	74.1	74.2	n.a.	73.6

Source: "Metals Week".

[1] High grade 99.7% purity. [2] Standard grade 99.5% purity.

n.a. Not applicable as contracts not traded.

TABLE 5. WORLD MINE PRODUCTION OF BAUXITE

	1985	1986	1987	1988
		(000 tonnes)		
Europe				
France	1 529.6	1 379.0	1 388.2	977.0
Greece	2 453.8	2 231.4	2 467.0	2 533.0
Italy	-	-	-	17.1
Spain	2.4	3.0	3.0	3.0
Yugoslavia	3 538.0	3 459.0	3 394.0	3 034.0
Total	7 523.8	7 072.4	7 252.2	6 564.1
Africa				
Ghana	169.5	204.0	196.2	285.0
Guinea	13 956.0	14 656.0	16 282.0	16 834.0
Mozambique	5.0	4.0	5.0	8.0
Sierra Leone	1 184.5	1 242.0	1 391.0	1 379.0
Zimbabwe	21.0	24.3	25.0	-
Total	15 336.0	16 309.2	17 899.2	18 506.0
Asia				
India	2 340.7	2 662.2	2 736.0	3 415.0
Indonesia	830.5	649.9	635.3	518.0
Malaysia	491.0	566.2	482.1	361.0
Pakistan	2.0	3.0	4.0	2.5
Turkey	213.8	280.4	258.0	269.0
Total	3 878.9	4 161.7	4 115.4	4 565.5
Americas				
United States	674.0	510.0	576.0	588.0
Brazil	5 846.0	6 446.3	6 566.5	7 727.6
Guyana	2 206.0	2 600.0	2 785.0	1 774.0
Jamaica	6 239.0	6 964.0	7 660.0	7 408.0
Surinam	3 738.3	3 730.6	2 581.1	3 434.0
Venezuela	-	-	217.0	550.0
Dominican Republic	-	-	-	167.8
Total	18 703.3	20 250.9	20 385.6	21 649.4
Australasia				
Australia	31 839.0	32 384.0	34 102.0	36 192.0
Eastern countries				
China	2 800.0	2 900.0	3 200.0	3 500.0
Hungary	2 814.8	3 022.3	3 101.1	2 906.0
Romania	460.0	500.0	480.0	500.0
U.S.S.R.	6 400.0	6 275.0	5 700.0	5 900.0
Total	12 474.8	12 697.3	12 481.1	12 806.0
World Total	89 755.8	92 875.1	96 235.5	100 283.0

Source: Energy, Mines and Resources Canada.
- Nil.

TABLE 6. WORLD PRODUCTION OF ALUMINA (HYDRATE)

	1985	1986	1987	1988
		(000 tonnes)		
Europe				
France	877.0	884.0	866.0	737.0
Germany, Federal Republic of	1 657.0	1 560.0	1 313.0	1 163.0
Greece	402.0	458.0	529.0	532.0
Ireland	557.0	685.0	787.0	842.8
Italy	555.0	618.0	700.0	705.0
Spain	729.0	748.0	801.0	881.0
United Kingdom	108.0	108.0	110.0	114.0
Yugoslavia	1 138.0	1 117.0	1 112.0	1 174.0
Total	6 023.0	6 178.0	6 218.0	6 148.8
Africa				
Guinea	565.0	572.0	542.0	593.0
Asia				
India	571.0	586.0	650.0	1 188.0
Japan	1 336.0	986.0	711.0	414.6
Turkey	113.0	142.0	95.2	182.0
Total	2 020.0	1 714.0	1 456.2	1 784.6
Americas				
Brazil	1 096.0	1 258.0	1 396.0	1 417.0
Canada	1 019.0	1 015.0	952.0	992.6[1]
Jamaica	1 622.0	1 586.0	1 572.0	1 514.0
Surinam	1 242.0	1 471.0	1 363.0	1 632.0
United States	3 465.0	3 105.0	4 150.0	4 650.0
Venezuela	1 135.0	1 269.0	1 360.0	1 284.0
Total	9 579.0	9 704.0	10 794.0	11 489.6
Australasia				
Australia	8 792.0	9 423.0	10 109.0	10 511.0
Eastern countries				
Czechoslovakia	75.0	70.0	75.0	75.0
Germany, Democratic Republic of	43.0[r]	46.0	50.9	51.0
Hungary	822.0	872.0	868.0	894.0
Romania	548.0	555.0	584.0	580.0
U.S.S.R.	4 350.0	4 740.0	4 425.0	4 600.0
China, People's Republic of	1 300.0	1 400.0	1 450.0	1 530.0
Total	7 138.0	7 683.0	7 452.9	7 730.0
World Total	34 117.0	35 274.0	36 571.8	32 257.0

Source: Energy, Mines and Resources Canada.
- Nil; [r] Revised.
[1] Calcined.

TABLE 7. WORLD PRODUCTION OF ALUMINUM

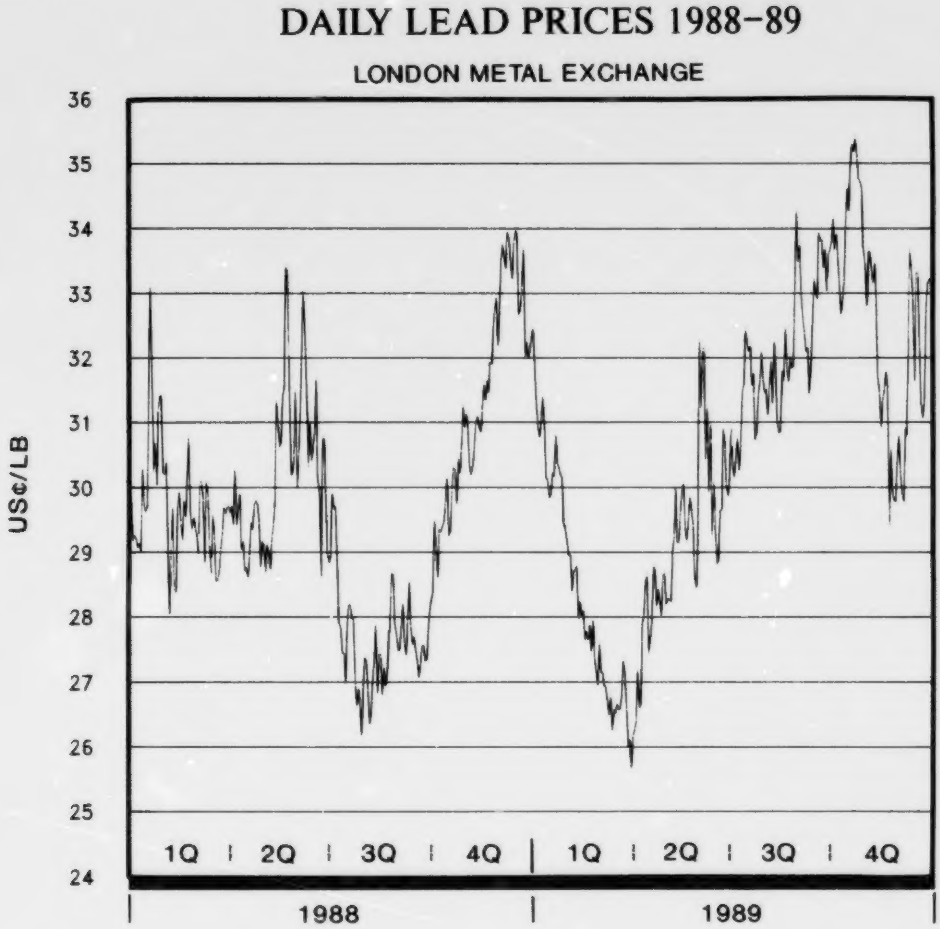
	1985	1986	1987	1988
		(000 tonnes)		
Europe				
France	293.2	321.8	322.5	327.7
Germany, Federal Republic of	745.4	763.7	737.7	744.1
Italy	224.1	242.6	232.6	226.3
Netherlands	243.9	258.0	268.7	270.7
Norway	724.1	729.1	797.8	826.6
Spain	370.1	354.7	341.0	293.9
United Kingdom	275.4	275.9	294.4	300.2
Yugoslavia	314.1	273.2	293.9	318.3
Other	450.6	454.6	459.0	497.0
Total	3 640.9	3 673.6	3 747.6	3 804.8
Africa				
Total	473.2	552.2	571.6	598.7
Asia				
Bahrain	174.8	178.2	180.3	182.8
India	266.5	257.1	267.2	334.5
Indonesia	216.8	218.8	201.4	185.0
Japan	226.5	140.2	40.6	35.3
Dubai	153.2	154.8	155.9	162.5
Other	114.6	117.3	103.8	113.3
Total	1 152.4	1 066.4	949.2	1 013.4
Americas				
Canada	1 282.3	1 355.2	1 540.4	1 534.5
United States	3 499.7	3 037.0	3 343.0	3 943.5
Brazil	549.4	757.4	843.5	873.5
Venezuela	402.5	423.3	439.6	443.4
Other	211.4	216.3	217.2	235.5
Total	5 944.9	5 789.2	6 383.7	7 030.4
Australasia				
Australia	851.7	876.8	1 024.2	1 141.3
New Zealand	243.5	236.2	252.0	265.7
Total	1 095.2	1 113.0	1 276.2	1 407.0
Eastern countries				
Romania	249.0	260.0	260.0	250.0
U.S.S.R.	2 300.0	2 350.0	2 370.0	2 440.0
China, People's Republic of	500.0	570.0	640.0	713.0
Other	222.6	218.5	225.4	225.0
Total	3 271.6	3 398.5	3 495.4	3 628.0
World Total	15 578.2	15 592.9	16 423.7	17 482.3

Source: Energy, Mines and Resources Canada.

TABLE 8. WORLD CONSUMPTION OF ALUMINUM

	1985	1986	1987	1988
	(000 tonnes)			
Europe				
Belgium/Luxembourg	267.7	273.3	284.7	302.3
France	586.1	592.6	615.6	660.6
Germany, Federal Republic of	1 160.9	1 186.7	1 185.7	1 232.6
Italy	470.0	510.0	548.0	581.0
Spain	211.0	240.0	254.7	268.0
United Kingdom	351.3	389.1	383.6	427.4
Yugoslavia	168.2	163.0	168.2	184.4
Other Europe	743.6	798.9	778.5	833.1
Total	3 958.8	4 153.6	4 219.0	4 489.4
Africa				
Total	203.7	191.6	230.6	232.1
Asia				
India	297.6	310.0	326.0	337.0
Japan	1 654.8	1 624.2	1 696.8	2 123.2
Other Asia	743.8	855.2	1 013.7	1 101.5
Total	2 696.2	2 789.4	3 036.5	3 561.5
Americas				
Canada	345.0	321.0	421.6	435.0
United States	4 282.0	4 316.0	4 539.0	4 598.1
Brazil	347.5	423.7	430.3	393.0
Other America	360.5	372.6	404.6	419.7
Total	5 335.0	5 433.3	5 795.5	5 845.8
Oceania				
Total	323.1	316.7	355.9	358.5
Eastern countries				
Germany, Democratic Republic of	230.0	227.0	230.0	225.0
Hungary	199.5	209.4	197.9	213.1
U.S.S.R.	1 750.0	1 750.0	1 800.0	1 800.0
China, People's Republic of	640.0	600.0	660.0	630.0
Other	478.0	481.6	484.7	483.4
Total	3 297.5	3 268.0	3 372.6	3 351.5
World Total	15 814.3	16 152.6	17 010.1	17 838.8

Source: Energy, Mines and Resources Canada.


DAILY LEAD PRICES 1988-89
LONDON METAL EXCHANGE
USc/LB
36
35
34
33
32
31
30
29
28
27
26
25
24
1Q
2Q
3Q
4Q
1Q
2Q
3Q
4Q
1988
1989

Asbestos

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In 1989, Canadian asbestos production increased 13.5% over 1988, due largely to the reopening of the Bell Asbestos Mine in Quebec. Canadian mines operated at close to 100% of current capacity, and average prices increased 5.9% due primarily to increased demand for short fibre. However, 1989 total shipments are estimated to be 691 000 tonnes (t), valued at $259 million compared to revised figures showing 710 358 t, valued at $251.1 million, in 1988. The 2.7% decline in shipments reflected the decreased demand in the United States, with much of this decline being attributed to the ongoing asbestos controversy and the Environmental Protection Agency's (EPA) announced final asbestos phase-out and ban rule on July 6, 1989. The U.S. Bureau of Mines estimates Canadian asbestos imports of 50 000 t for 1989 compared to 71 400 t in 1988.

Export volumes estimated for 1989 show a decline of 13.8% from the previous year although the value of the exports was 16% higher. Exports in the January to September 1989 period totalled 532 451 t, valued at $333.7 million, compared to 617 724 t, valued at $287 million, for the same period in 1988.

Employment in asbestos mining/milling increased slightly to 2800 workers in Quebec, British Columbia and Newfoundland. Reopening of the Bell Asbestos Mine has meant employment for 450 workers. During the course of the year, J M Asbestos Inc. had several minor shutdowns which totalled eight weeks. Baie Verte Mines Inc. (BVM) laid off 60 workers near the end of the year due to an overall slowdown as only three years of ore remain in its pit. Asbestos workers represent 4.3% of those in the Canadian nonfuel mineral industry and 12% of mine/mill workers in Quebec.

According to Statistics Canada, asbestos mines contribute 0.05% to the gross domestic product (at factor cost) and in 1989 the value was approximately $420 million.

CANADIAN DEVELOPMENTS

Cassiar Mining Corporation, which through a corporate reorganization in December became a wholly-owned subsidiary of Princeton Mining Corporation, depleted its open-pit ore reserves at mid-year. Stockpiled ore will enable the mill to continue operations until the expected starting date of the McDame underground mine in the middle of 1990. The $45 million McDame development has proven reserves for about 10 years' operation yielding high quality fibre; the daily mill ore feed rate will be 5500 t. Fibre produced from Cassiar's wet processing operation, named "aquafine" is being sold for specialty products and has been well received in the market place.

BVM completed the year by showing its first annual operating profit. In January, BVM became wholly-owned by 724728 Ontario Limited, a subsidiary of Cliff Resources Corporation which is controlled by First Toronto Mining Corporation and Mineral Commodities Limited of Australia. The $16 million construction of plant and facilities for its wet-processing operation, for the secondary recovery of short fibre from tailings, is proceeding on schedule. BVM has three years remaining in its open-pit; wet-processing is expected to extend the life of BVM by 15 to 20 years. The company is also considering an underground development as the orebody at depth is significant and of high grade. However, a final decision is not expected for some time.

J M Asbestos Inc. operated at less than full capacity. It has the largest share of the U.S. market and, consequently, has been negatively impacted by the regulatory action of the EPA.

In September, Lac d'Amiante du Quebec, Ltee (LAQ) of Black Lake was purchased from ASARCO Incorporation of New York by a partnership involving Jean Dupéré, President of LAB Chrysotile Inc. and Connell Bros. Company, Ltd. of the United States. The purchase price was US$11.7 million.

INTERNATIONAL AND REGULATORY DEVELOPMENTS

Two quite different regulatory developments were noteworthy during 1989. First, the United States EPA announced its final asbestos rule on July 6. This rule, promulgated under the Toxic Substances Control Act (TSCA) which EPA initiated in 1979, prohibits at staged intervals the future manufacture, importation, processing and distribution in commerce of 94% of current asbestos products used in the United States. Stage I comes into effect September 1, 1990 and represents 10% of current uses (felt products and asbestos cement sheet); Stage II commences September 1, 1993 and represents 18% of current uses (friction products in the original equipment market and gaskets); and Stage III commences September 1, 1996 affecting 66% of current uses (coatings, friction products in the aftermarket, paper products, asbestos cement pipe and shingle). The rule exempts: mining and milling of asbestos, missile liners, asbestos diaphragms and packings, battery separators, arc chutes, acetylene cylinders, asbestos reinforced plastic, sealant tape and electrical paper. TSCA allows for appeals to be made to the U.S. Court of Appeals, and by the deadline date of September 24, 1989, 31 appeals had been filed by United States and Canadian entities over EPA's rule. Appeal briefs will be filed during 1990 although a Court ruling is not expected until late 1991.

The European Communities (EC) reviewed its workplace Directives and proposed tightening occupational regulations. The limit for concentration of chrysotile (white) asbestos fibres in the air at the place of work was reduced from 1 f/cc to 0.8 f/cc; and the workplace exposure limit for amosite (brown) and crocidolite (blue) asbestos was reduced from 0.5 f/cc to 0.3 f/cc. These regulations, although strict, are achievable given current technology and serve to protect workers from occupational risk.

The International Labour Organizations' (ILO) Convention No. 162 on Safety in the Use of Asbestos came into force as an international instrument in June. Sweden, Canada, Finland, Cameroon, Guatemala, Yugoslavia and Brazil have ratified this Convention, the implementation of which will benefit asbestos workers worldwide.

SCIENTIFIC DEVELOPMENTS

In April, a World Health Organization Meeting of Experts, under the Chairmanship of Sir Richard Doll was held and attended by leading researchers and epidemiologists from 13 countries. This group reviewed all the scientific data with the view to providing advice and guidance on occupational exposure levels for asbestos to those countries, particularly in the developing world, which are considering ratification of the ILO Asbestos Convention. The Report, released in November, concluded that a level of control of chrysotile asbestos can be achieved at which the lifetime risks of lung cancer or mesothelioma are non-existent or too small to be measured by present studies. Secondly, the Report recommended that the occupational exposure limit for chrysotile should ultimately be 1 f/cc or less, with the initial target being 2 f/cc or less. Thirdly, it recommended that no exposure should be permitted to crocidolite or amosite except in special circumstances where worker protection is totally adhered to.

The OECD Report on "Control of Toxic Substances in the Atmosphere - Asbestos" was released in April and stated that: "the risk of asbestos associated with exposure to the low levels of asbestos present in the ambient air is probably negligible and that the strategies to limit exposure of the general population should be based on consideration of the more significant risks of lung cancer and mesothelioma associated with the inhalation of (high) airborne asbestos (levels)...". The Report also indicated that the risk of lung cancer to those in occupational situations is increased by cigarette smoking, and it suggested that the amphiboles are more potent in the induction of mesothelioma than is chrysotile.

In August, Harvard University's Energy and Environmental Policy Centre issued its "Summary of the Symposium on Health Aspects of Exposure to Asbestos in Buildings" and concluded that the general public's fear in this area is "out of proportion to the public health risk". It also noted that "removal of asbestos materials, if done improperly, may actually increase health risks not only to removal workers, but also to building occupants.... Fibre concentrations found in occupational settings have been associated with increased risk of ...disease. These concentrations, however, are several thousand times higher than those presently found inside commercial, residential and school buildings."

OTHER FIBRES

The ILO convened a Meeting of Experts, in April, on Safety in the Use of Mineral and Synthetic Fibres. While manufacturers of other fibrous materials were reluctant to make comparisons to asbestos for legal and liability reasons, the Experts concluded that all durable and respirable fibres should be considered hazardous. The Experts considered both mineral and synthetic fibres which include, but are not limited to erionite, attapulgite, and wollastonite. Man-made mineral fibres (MMMF) include insulation wools, refractory (ceramic) fibres, continuous filament and special purpose fibres. Synthetic fibres include organic fibres derived from monomeric chemicals and MMMF, as well as artificial fibres of either natural vegetable or animal origin.

The Experts concluded by recommending to the ILO Board of Governors that: research efforts be enhanced on the biological effects of these fibres; all such fibres be thoroughly pretested prior to being put on the market; governments be encouraged to control and regulate these fibres; a Code of Practice be prepared for insulation wools; and that the Experts Group reconvene in about three years to review new evidence on these fibres and to recommend further action to the ILO.

OUTLOOK

It is anticipated that demand for short fibre used in inexpensive, asbestos-containing materials for domestic needs such as roofing tiles, siding and sheet will continue through the next year due to the worldwide housing boom. Canadian production is expected to increase marginally with additions of fibre from wet-processing. The market situation is expected to remain stable, though uncertain, until the regulatory situation in the United States has been clarified.

Note: Information contained in this review was current as of mid-January 1990.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2524.00	Asbestos				
2524.00.10	--- Crude	Free	Free	Free	Free
2524.00.90	--- Other	8%	5%	Free	Free
68.11	Articles of asbestos-cement, of cellulose fibre-cement or the like				
6811.10.00	- Corrugated sheets	8%	5%	4.8%	Free
6811.20.00	- Other sheets, panels, tiles and similar articles	8%	5%	4.8%	Free
6811.30.00	- Tubes, pipes and tube or pipe fittings	8%	5%	4.8%	0.2¢ kg
6811.90.00	- Other articles	8%	5%	4.8%	Free
68.12	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate; articles of such mixtures of asbestos				
6812.10.00	- Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	8%	5%	4.8%	Free
6812.20.00	- Yarn and thread	12.5%	12.5%	7.5%	Free
6812.30.00	- Cords and string, whether or not plaited	12.5%	12.5%	7.5%	Free
6812.40.00	- Woven or knitted fabric	8%	5%	6%	Free
6812.50.00	- Clothing, clothing accessories, footwear and headgear	25%	25%	15%	2.4% to 10%
6812.60.00	- Paper, millboard and felt	8%	5%	4.8%	Free
6812.70.00	- Compressed asbestos fibre jointing, in sheets or rolls	8%	5%	4.8%	Free
6812.90	- Other				
6812.90.10	--- Belting	17.5%	7.5%	10.5%	Free
6812.90.90	--- Other	8%	5%	4.8%	Free
68.13	Friction material and articles thereof, not mounted for brakes, for clutches or the like, with a basis of asbestos, of other mineral substances or of cellulose				
6813.10	- Brake linings and pads				
6813.10.10	--- For motor vehicles of heading No. 87.02, 87.03, 87.04 or 87.05	11.3%	Free	9%	Free
6813.10.90	--- Other	8%	5%	6.4%	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, ASBESTOS PRODUCTION AND TRADE, 1988 AND 1989

Item No.		1988		1989^p	
		(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]					
By type					
	Crude, groups 1, 2 and other milled	14	2	. .	. .
	Group 3, spinning	10 491	8 773	. .	. .
	Group 4, shingle	245 601	130 096	. .	. .
	Group 5, paper	143 458	50 196	. .	. .
	Group 6, stucco	183 028	43 834	. .	. .
	Group 7, refuse	127 765	18 187	. .	. .
	Total	710 357	251 088	691 000	258 691
By province					
	Quebec	529 564	169 951	519 000	176 716
	British Columbia	109 139	54 242	108 000	57 800
	Newfoundland	71 654	26 895	64 000	24 175
	Total	710 357	251 088	691 000	258 691
Exports				**(Jan.-Sept.)**	
2524.00	- Asbestos				
2524.00.10	--- Crude				
	EEC countries (12)[1]	1 168	717	361	242
	India	5 915	2 616	2 818	1 340
	Japan	1 838	678	1 977	658
	United States	813	491	322	191
	Thailand	754	583	200	136
	Other countries	800	393	670	357
	Total	11 288	5 478	6 348	2 924
2524.00.21	--- Milled fibres, group 3 grades				
	EEC countries (12)[1]				
	United Kingdom	1 505	1 886	1 413	1 811
	Belgium	-	-	619	769
	Spain	767	739	484	530
	Italy	285	314	248	310
	Portugal	407	423	160	245
	West Germany	705	451	176	243
	France	698	552	102	123
	Other EEC countries	140	44	-	-
	EEC countries subtotal	4 507	4 409	3 202	4 031
	United States	2 964	1 510	1 039	1 275
	Mexico	835	1 407	542	910
	Brazil	843	1 451	638	848
	Turkey	325	252	605	786
	Czechoslovakia	405	554	590	759
	Japan	1 420	1 705	495	605
	South Korea	824	1 149	346	357
	Peru	270	276	216	330
	People's Republic of China	245	508	171	231
	India	145	211	156	211
	Thailand	762	567	229	154
	Other countries	1 257	1 288	528	673
	Total	14 802	15 287	8 757	11 170

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
2524.00.22	--- Milled fibres, groups 4 and 5 grades				
	EEC countries (12)[1]				
	Italy	28 064	20 720	24 483	20 665
	France	30 715	21 890	20 805	16 371
	Spain	15 144	11 505	11 703	10 812
	West Germany	15 088	10 197	8 251	7 575
	Belgium	7 399	5 916	5 366	5 148
	United Kingdom	7 416	5 677	5 233	4 632
	Portugal	4 623	5 073	3 352	3 541
	Other EEC countries	5 420	10 319	4 484	4 460
	EEC countries subtotal	113 869	91 297	83 677	73 204
	Japan	39 418	25 329	53 976	39 285
	India	29 126	23 269	19 835	16 531
	Thailand	28 589	18 226	19 104	10 902
	Algeria	5 892	5 343	11 850	9 227
	Malaysia	12 485	7 932	10 777	8 911
	United States	17 901	13 400	8 810	7 129
	Austria	8 930	7 100	6 625	5 586
	Colombia	10 331	6 194	6 423	4 530
	Turkey	5 800	5 132	4 543	4 368
	Pakistan	3 562	2 537	5 007	4 125
	Other countries	90 856	68 456	58 483	49 105
	Total	366 759	274 215	289 110	232 903
2524.00.29	--- Shorts, groups 6, 7, 8 and 9 grades				
	EEC (12)[1]				
	West Germany	6 793	2 729	7 713	4 177
	Belgium	6 091	1 850	4 980	2 316
	Italy	2 748	1 800	6 529	2 367
	United Kingdom	6 700	2 027	5 529	1 994
	Spain	7 931	2 941	4 670	1 958
	France	2 126	776	3 963	1 868
	Other EEC countries	6 236	2 267	5 942	3 110
	EEC countries subtotal	38 625	14 390	39 326	17 790
	Japan	58 468	19 218	39 983	14 477
	South Korea	37 484	12 725	31 607	10 376
	Thailand	21 067	8 768	22 905	9 865
	United States	57 351	11 947	33 035	8 582
	India	12 445	4 473	10 384	3 860
	Taiwan	14 125	4 518	8 576	2 698
	Mexico	9 386	2 594	7 850	2 618
	Malaysia	3 255	1 231	4 231	2 272
	Turkey	6 056	2 761	4 566	2 042
	Indonesia	2 823	915	3 553	1 690
	Other countries	31 151	11 260	22 220	10 414
	Total	292 236	94 800	228 236	86 684
Grand total crude, milled fibres and shorts		685 085	389 780	532 451	333 681

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
68.11	Articles of asbestos-cement, of celulose fibre-cement or the like				
6811.10	- Corrugated sheets				
	United States	..	314	–	–
	Nicaragua	..	90	–	–
	Total	..	404	–	–
6811.20	- Other sheets, panels, tiles and similar articles				
	United States	..	592	..	337
	New Zealand	..	411	–	–
	Other countries	..	105	–	–
	Total	..	1 108	..	337
6811.30	- Tubes, pipes and tube or pipe fittings				
	Dominica	..	–	..	26
	United States	..	30	–	–
	Total	..	30	..	26
6811.90	- Other articles				
	United States	..	206	..	330
	Other countries	..	30	..	13
	Total	..	236	..	343
68.12	Fabricated asbestos fibres: mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate, articles of such mixtures or of asbestos				
6812.10	- Fabricated asbestos fibres				
	United States	..	529	..	858
	France	–	–	..	132
	Japan	..	89	..	92
	Other countries	..	1 087	..	185
	Total	..	1 705	..	1 267
6812.20	- Yarn and thread				
	United States	175	955	106	1 261
	Other countries	73	331	240	581
	Total	248	1 286	346	1 842
6812.30	- Cords and string, whether or not plaited				
	Colombia	..	–	..	21
	Other countries	..	60	..	19
	Total	..	60	..	40
6812.40	- Woven or knitted fabric				
	United States	52	394	203	481
	United Kingdom	63	501	58	306
	Other countries	36	159	4	52
	Total	151	1 054	265	839

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
6812.50	- Clothing, clothing accessories, footwear and headgear				
	United Kingdom	..	55	..	79
	France	–	–	..	14
	Other countries	..	540	..	50
	Total	..	595	..	143
6812.60	- Paper, millboard and felt				
	United States	..	4 306	..	1 493
	Australia	..	42	..	221
	Other countries	..	592	..	185
	Total	..	4 940	..	1 899
6812.70	- Compressed asbestos fibre jointing, in sheets or rolls				
	United States	293	579	223	693
	Other countries	1	60	857	485
	Total	294	639	1 080	1 179
6812.90	- Other				
6812.90.10	--- Building materials				
	United States	..	4 642	..	929
	Japan	..	115	..	269
	Other countries	..	1 182	..	219
	Total	..	5 939	..	1 417
6812.90.90	--- Other				
	United States	..	3 037	..	603
	U.S.S.R.	–	–	..	571
	Kuwait	–	–	..	343
	Other countries	–	633	..	444
	Total	..	3 670	..	1 961
68.13	Friction material and articles thereof, not mounted, for brakes, for clutches or the like, with a basis of asbestos, of other mineral substances or of cellulose				
6813.10	- Brake linings and pads				
	United States	..	15 493	..	5 648
	Other countries	..	913	..	526
	Total	..	16 406	..	6 174
6813.90	- Other				
6813.90.10	--- Clutch facings for motor vehicles				
	United States	..	6	–	–
	Total	..	6	–	–
6813.90.90	--- Other				
	United States	..	435	..	15
	Other countries	..	90	..	20
	Total	..	525	..	35
Total exports, asbestos manufactured		..	38 603	..	17 502

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989[p]	
		(tonnes)	($000)	(tonnes)	($000)
Imports					
2524.00	Asbestos				
2524.00.10	---Crude	254	351	189	264
2524.00.90	---Other	129	36	646	313
68.11	Articles of asbestos-cement, of cellulose fibre-cement or the like				
6811.10.00	- Corrugated sheets	. .	28	. .	99
6811.20.00	- Other sheets, panels, tiles and similar articles	. .	662	. .	699
6811.30.00	- Tubes, pipes and tube or pipe fittings	. .	64	. .	1 899
6811.90.00	- Other articles	. .	862	. .	537
68.12	Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate; articles of such mixtures or of asbestos				
6812.10.00	- Fabricated asbestos fibres; mixtures with a basis of asbestos or with a basis of asbestos and magnesium carbonate	. .	357	. .	224
6812.20.00	- Yarn and thread	15	115	19	208
6812.30.00	- Cords and string, whether or not plaited	. .	81	. .	29
6812.40.00	- Woven or knitted fabric	43	480	30	405
4812.50.00	- Clothing, clothing accessories, footwear and headgear	. .	241	. .	263
6812.60.00	- Paper, millboard and felt	. .	690	. .	808
6812.70.00	- Compressed asbestos fibre jointing, in sheets or rolls	233	1 999	158	1 125
6812.90	- Other				
6812.90.10	--- Belting	. .	4	. .	9
6812.90.90	--- Other	. .	5 268	. .	3 055
68.13	Friction material and articles thereof, not mounted, for brakes, for clutches or the like, with a basis of asbestos, of other mineral substances or of cellulose				
6813.10	- Brake linings and pads	. .	25 211	. .	22 432
6813.90	- Other	. .	4 027	. .	3 251

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] EEC includes Belgium, Denmark, France, West Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain and United Kingdom.

[p] Preliminary; – Nil; . . Not applicable.

Note: Numbers may not add to totals due to rounding

TABLE 2. CANADIAN ASBESTOS PRODUCERS, 1989

Producers	Mine Location	Normal Mill Capacity		Remarks
		ore/day	fibre/year	
		(tonnes)		
Baie Verte Mines Inc.	Baie Verte, Nfld.	6 600	80 000	Open-pit; wet-processing facility under development.
LAB Chrysotile Inc.[1]				Partnership owned 55% LAQ and 45% Société nationale de l'amiante (SNA).
- Lac d'Amiante du Québec, Ltée (LAQ)	Black Lake, Que.	9 000	160 000	Open-pit. Since September LAQ is owned by Jean Dupéré (President of LAB) and Connell Bros. Company, Ltd. of the United States.
- Asbestos Corporation Limited				(SNA) Quebec Crown corporation.
British Canadian mine	Black Lake, Que.	7 000	70 000	Open-pit.
- Bell Asbestos Mines, Ltd.	Thetford Mines, Que.	2 700	70 000	(SNA) Quebec Crown corporation. Underground. Mine was reopened January 1989.
J M Asbestos Inc. Jeffrey mine	Asbestos, Que.	15 000	300 000	Open-pit (effective capacity reduced by one-half since 1982).
Cassiar Mining Corporation	Cassiar, B.C.	5 000	100 000	Open-pit; some wet-milling production; development work for underground McDame orebody progressing.
Total of four producers at year-end			780 000	

[1] A partnership involving three operating companies.

TABLE 3. CANADA, ASBESTOS PRODUCTION AND EXPORTS, 1983-89

	Crude	Milled	Shorts	Total
		(tonnes)		
Production[1]				
1983	–	448 953	408 551	857 504
1984	–	442 503	394 151	836 654
1985	–	397 729	352 461	750 190
1986	–	332 092	330 289	662 381
1987	–	365 144	299 402	664 546
1988	14	399 550	310 793	710 357
1989[p]	. .	. .	. .	691 000
Exports				
1983	931	384 068	368 912	753 911
1984[r]	45	430 407	366 206	796 658
1985	44	395 158	326 311	721 513
1986	127	375 948	341 609	717 684
1987	1 696	353 321	293 808	648 825
1988	11 288	381 561	292 236	685 085
1989[2]	6 348	297 867	228 236	532 451

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Producers' shipments. [2] January-September.
[p] Preliminary; – Nil; . . Not available; [r] Revised.

TABLE 4. CANADIAN ASBESTOS CONSUMPTION, 1986–88

	1986		1987		1988[p]	
	(tonnes)	(%)	(tonnes)	(%)	(tonnes)	(%)
Paper; textiles, a/c sheet; a/c pipe; insulation; roofing	7 165	52	5 662	52	5 898	56
Flooring products, plastics; coatings and compounds	3 243	24	1 003	9	89	1
Friction products; packing and gaskets	3 273	24	4 278	39	4 559	43
Total	13 681	100	10 943	100	10 546	100

[p] Preliminary.

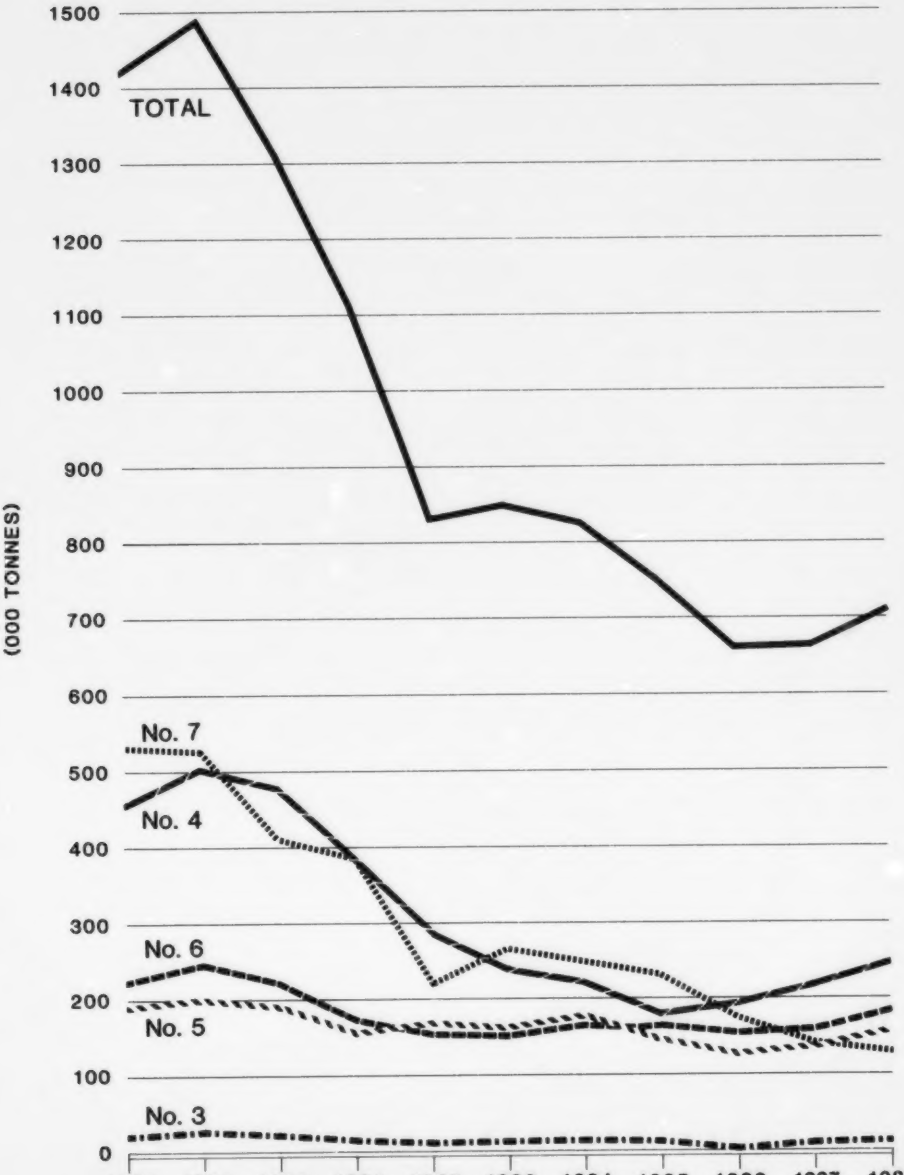
TABLE 5. ASBESTOS: WORLD PRODUCTION BY COUNTRY, 1989

Country	Tonnes[e]
U.S.S.R.	2 560 000
Canada	708 000
Brazil	230 000
Zimbabwe	191 000
China	160 000
Republic of South Africa	156 000
Italy	40 000
United States	18 000
Greece	80 000
India	32 000
Indonesia	25 000
Swaziland	21 000
Cyprus	0
Colombia	13 000
Yugoslavia	20 000
Japan	4 000
Korea	3 000
Turkey	1 500
Argentina	1 000
Bulgaria	500
Egypt	400
Total	4 264 400

Sources: U.S. Bureau of Mines; Energy, Mines and Resources Canada.

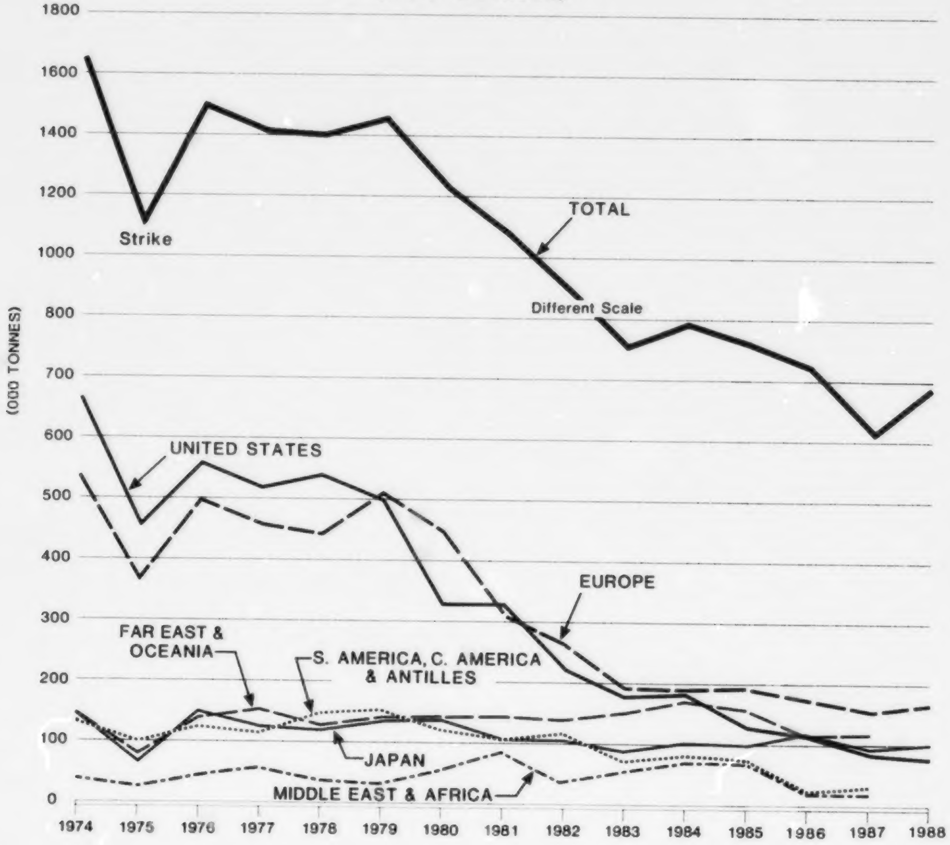
[e] Estimated.

CANADIAN ASBESTOS SHIPMENTS
1978-88



CANADIAN EXPORTS OF ASBESTOS (ALL GROUPS) BY COUNTRY OR REGION (1974-88)

(000 Tonnes)



NOTE: NEW HARMONIZED SYSTEM DOES NOT ALLOW FOR UPDATING OTHER COUNTRY DATA.

Cement

1989

O. Vagt

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In 1989, construction activity in Canada was buoyant based mainly on strength in the commercial and industrial/engineering sectors. The residential sector was slightly weaker although housing starts were higher than originally forecast for most regions. Total cement shipments were 12.6 Mt, slightly higher than in 1988, based on preliminary figures. Trade with the United States in both portland cement and clinker was lower. Canadian cement production capacity decreased slightly to 14.4 Mt/y because of a plant closure.

After general economic recovery from the 1982-84 period of recession, construction expenditures related particularly to residential building expanded rapidly. The commercial and institutional building sectors expanded more slowly, and engineering construction expenditures, with gas and oil accounting for up to one third, continued relatively low until a broader upturn began in 1988.

THE CANADIAN INDUSTRY

The Canadian cement industry is diversified and vertically integrated into the closely related construction materials and products fields. Many cement manufacturers also supply ready-mix concrete, stone, aggregates and concrete products such as slabs, bricks and pre-stressed concrete units. The industry is about 80% foreign controlled and it is strongly regionalized with capacity situated near growth areas in Canada and, in some cases, the United States. In fact, some plants were located for ready access to existing U.S. markets by utilizing water-borne, high-bulk transportation facilities. Recently, major international companies have purchased Canadian-based cement operations. These include the S.A. Cimenteries CBR of Belgium purchase of Genstar Cement Limited (now renamed Inland Cement Limited), and the Société des Ciments Français acquisition of Lake Ontario Cement Limited. The CBR plants in the "inland" western provinces continue to operate under the name, Inland Cement Limited. In British Columbia, CBR's cement operations conduct business under the name of Tilbury Cement Limited, with production facilities in Delta and distribution centres throughout the province.

St. Lawrence Cement Inc. also expanded in recent years by acquiring cement plants along with distribution terminals in New York and Maryland. The company is currently involved with a major investment in Hudson, New York, to build a US$190 million, 900 000 t/y cement plant situated to supply the important northeastern U.S. market.

St. Marys Cement Corporation, with a plant in Detroit, several distribution terminals in four states, and a precast concrete plant in Michigan, announced plans to diversify further into the United States.

Lake Ontario Cement Limited is well integrated into the concrete products field and a recent acquisition in the United States provides a major extension of the company's current market area as far south as the Carolinas. In 1989, Lake Ontario Cement Limited, a subsidiary of Paris-based Société des Ciments Français, completed its takeover of Miron Inc., which currently has no clinker-producing capacity but operates ready-mix plants in Quebec and Ontario.

Lafarge Corporation, the parent company of Montreal-based Lafarge Canada Inc. which operates across Canada, purchased a cement plant in Washington State, along with distribution terminals in Washington and Montana. Shipments by the Canadian subsidiary continued strong, including those destined to the new Great Lakes distribution network.

Clinker-producing and finish-grinding capacities for cement are listed in Table 2, the former being the best measure of a plant's cement manufacturing capacity given that clinker can be stockpiled or purchased from outside sources. For this reason, plant-grinding capacities may be significantly greater than their capabilities for producing primary-stage clinker which is dependent on the necessary raw materials.

Two plants in the **Atlantic region**, which obtain raw materials on-site or nearby, account for about 4% of total Canadian clinker-producing capacity. North Star Cement Limited completed its modernization program and is now capable of producing specialty cements as well as Normal Portland cement at its Corner Brook, Newfoundland plant. The Lafarge Canada Inc. plant at Havelock, New Brunswick, with grinding capacity of 315 000 t/y, was retired in 1988. Previously, clinker was provided on a demand basis from the company's Brookfield, Nova Scotia plant.

In the **Quebec region**, four clinker-producing plants account for about 24% of Canadian output in a region which in 1988 consumed about 2.1 Mt of portland cement, or 25% of total Canadian consumption.

Portland cement consumption in the **Ontario region** increased in 1989 where more than 40% of the nation's clinker-producing capacity is situated. Lafarge Canada Inc. has brought into production about 3 Mt of new cement capacity over the past 12 years and most of its operating kilns are relatively new. Limestone for Lafarge's Bath, Ontario plant is quarried on-site and silica is supplied from Potsdam sandstone at Pittsburgh, about 65 km east of Bath. Iron oxide and gypsum are purchased from Hamilton and Nova Scotia, respectively. The Woodstock plant obtains limestone on-site, silica from Falconbridge Limited, iron oxide from Stelco Inc. and gypsum from southern Ontario.

At Picton, Lake Ontario Cement Limited operates one of the largest cement plants in North America. The four-kiln plant supplies cement and clinker to its associated companies in the United States - Rochester Portland Cement Corp. in New York State and Aetna Cement Corporation in Michigan - and cement to its Ontario markets.

St. Lawrence Cement Inc. completed work on a kiln modification and plans to increase capacity effective in 1991 at its Mississauga plant. The company continued work on its Resource Recovery/Refuse Derived Fuel (RDF) project. Following an acceptable assessment by environmental authorities, plans are to replace up to 20% of the company's coal consumption with RDF produced from local non-hazardous municipal wastes. Expanding aggregate operations and reserves of raw material remain major objectives. Gypsum is purchased from Nova Scotia or from southern Ontario mines.

St. Marys Cement announced plans for a $160 million plant expansion to at least double production capacity at Bowmanville by mid-1991. A state-of-the-art, dry-process system will replace two wet process kilns and production of limestone on-site will be increased accordingly.

Two companies, Lafarge Canada Inc. and CBR's Inland/Tilbury operations, operate a total of four clinker-producing plants in the **Prairie region** and three in the **Pacific region**. This broad **Western region** accounts for about 30% of clinker-producing capacity, roughly in proportion to its share of total Canadian consumption.

A limestone quarry at Mafeking, Manitoba near the Manitoba-Saskatchewan border, supplies limestone to Inland's Regina plant, while the Winnipeg plant is supplied from Steep Rock, Manitoba.

Raw materials for Lafarge's Exshaw plant are mainly from on-site sources, whereas gypsum and iron oxide respectively, are provided by Westroc Industries Limited and Cominco Ltd. Lafarge's Vancouver plant at Richmond, as well as Tilbury's plant, utilizes limestone from Texada Island. The company's Kamloops plant is supplied from reserves nearby.

WORLD DEVELOPMENTS

World cement production in 1988 was 1100 Mt, according to the U.S. Bureau of Mines. China ranked number one, leading all countries with 203 Mt, followed by the U.S.S.R. at 138 Mt and the United States at 71 Mt.

Most countries are capable of supplying their own raw material requirements for cement manufacture when a plant is warranted. Normally, market range is strictly limited by transportation costs; however, large additional sales may warrant secondary distribution terminals. Few countries rely entirely on imports for their cement needs. However, in recent years multinational companies with widespread production and distribution networks have become much more important in world markets. An outstanding recent example of this is the partial consolidation of the United States, Canada and Mexico cement industries to effect very broad regional marketing. At present, more than 60% of the U.S. industry is controlled by European and Pacific Rim cement producers.

CONSUMPTION AND TRADE

Portland cement is produced by burning, usually in a rotary kiln, an accurately proportioned, finely ground mixture of limestone, silica, alumina and iron oxide. The three most commonly used types of cement are Normal Portland, High-Early-

Strength Portland and Sulphate-Resisting Portland, produced by most Canadian cement manufacturers. Concrete has become a readily adaptable material capable of being poured on-site for large engineering projects, or used in the form of delicate precast panels or as heavy, pre-stressed columns and beams in building construction.

Consumption of cement or concrete is about evenly distributed between the residential, non-residential and public-related construction sectors of the economy.

The trend continues toward an interconnected North American cement market. Low-cost marine transportation has influenced trade considerably with imports now providing about 20% of consumption in the United States.

Exports of Canadian cement and clinker are mainly to bordering states, particularly New York, Vermont, Michigan, Minnesota and Washington. Canadian cement production efficiencies and a relatively strong American dollar continue to make Canadian cement and clinker competitive in their own right. Concerns relating to low-cost imports into the United States from Mexico, Spain and Venezuela altered somewhat in favour of broader strategies taking advantage of low prices. However, late in the year, seven U.S. producers filed a petition asking the U.S. International Trade Commission and the U.S. Department of Commerce to impose antidumping duties.

TECHNOLOGY

Objectives continue to be directed toward using cheaper fuels, improving methods for defining optimum particle sizes based on grinding, and using waste materials in kilns because pyro processing accounts for more than 80% of total energy needs. Plants that used waste as a primary fuel in 1988 were Lafarge Canada Inc. in Richmond, British Columbia and St. Marys Cement in Bowmanville, Ontario. Energy conservation programs adopted by the Canadian cement industry have reduced the energy consumption per unit of production by 22.6% between 1974 and 1988. In 1988, the Canadian cement industry on average consumed 4817 megajoules per tonne of production of which 4281 megajoules was derived from fossil fuels.

The fuel mix has changed considerably during recent years away from natural gas and petroleum products toward coal/coke. In 1988, percentages were 70.2% for coal and coke, and 26.0% and 3.8% respectively for natural gas and petroleum products. Dry process plants accounted for 81.8% of total Canadian cement production in 1988.

Ongoing research sponsored through the Canada Centre for Mineral and Energy Technology (CANMET) and relating to supplementary cementing materials led to the successful use of blast furnace slag for manufacturing a slag cement. Reiss Lime Company of Canada, Limited is now producing this type of cement from a grinding plant at Spragge, Ontario, using granulated slag from The Algoma Steel Corporation, Limited's, Sault Ste. Marie plant. Plant capacity is 200 000 t/y of slag cement for complete or partial replacement of Portland cement, depending on requirements. The primary use at present is in mine backfill, however, construction-related uses are also being investigated.

CANMET, along with the American Concrete Institute as leading sponsors and the National Research Council as a co-sponsor, hosted in Ottawa the third International Conference on Super Plasticizers and Other Chemical Admixtures in Concrete.

Research in the private sector is conducted on behalf of all cement producers by the Portland Cement Association (PCA), a non-profit research group sponsored by the cement industry. In the case of Lafarge, the new Montreal-based facility is mandated "to develop new manufacturing processes and improve cement and concrete products tailored to the Canadian and U.S. markets."

Moderate Portland Cement and Low-Heat-of-Hydration Portland Cement, designed for concrete poured in large masses, such as in dam construction, are manufactured by several companies in Canada. Masonry cement (generic name) includes such proprietary product names as Mortar Cement, Mortar Mix (unsanded), Mason's Cement, Brick Cement and Masonry Cement. The latter product produced by Portland cement manufacturers is a mixture of Portland cement, finely ground high-calcium limestone (35-65% by weight) and a plasticizer. The aforementioned products do not necessarily consist of Portland cement and limestone, but may include mixtures of Portland cement and hydrated lime and/or other plasticizers.

Portland cement used in Canada should conform to the specifications of CAN 3-A5-M83, published by the Canadian Standards Association (CSA). This standard covers the five main types of

Portland cement. Masonry cement produced in Canada should conform to the CAN 3A8-M83. Blended hydraulic cements are covered by CAN 3-A362-M83. The cement types manufactured in Canada, but not covered by the CSA standards, generally meet the appropriate specifications of the American Society for Testing and Materials (ASTM).

OUTLOOK

Economic recovery, in the seventh year of expansion since 1982, slowed to an inflation-adjusted growth rate of about 2.0% in the third quarter of 1989. This weakness was a continuation of the downward trend beginning in 1988. Upward pressure on interest rates continued. The general trend of Canadian business investment including machinery and equipment has been downward since the first quarter in 1988. In the case of non-residential construction however, there has been general stability since late 1988, with an increase of 2.5% in the third quarter of 1989. Housing starts rose to 245 986 in 1987, decreased to 222 562 in 1988 and decreased further to about 215 000 in 1989. Uncertain factors in the outlook for building construction include relatively high short-term interest rates, the impact of the proposed 7% Goods and Services Tax before it replaces the existing manufacturing sales tax in 1991 and slightly higher consumer prices. Housing starts in 1990 are expected to be weaker at a more sustainable level of about 200 000 annually. Forecasted expansions of 2.8% and 2.5% in 1989 in Ontario and Quebec respectively are expected to be lower in 1990 according to most sources.

The Canadian Construction Association is predicting increases of about 4% (in constant dollar expenditures) in the non-residential contract construction industry through the 1989-91 period. The construction industry as a whole has expressed concern that Canada's large infrastructure network deserves attention now rather than delaying until major renovation and upkeep projects are needed. Such a program would permit the construction industry, and the dependent portion of the mining industry, to plan five to ten years ahead with overall benefits in efficiency.

Conservation of energy and raw materials is a worldwide concern and a factor influencing major developments in the industry. Objectives to reduce costs will focus on the use of cheaper fuels, technological advances and more use of waste materials to heat kilns. Also, the use of blended cements as well as the utilization of slag, ash and other by-products will continue to grow.

Note: Information contained in this review was current as of mid-January 1990.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2523.10	- Cement clinker	Free	Free	Free	Free
	- Portland cement				
2523.21	-- White cement whether or not artificially coloured	81.59¢/t	54.25¢/t	Free	Free
2523.29	-- Other	Free	Free	Free	Free
2523.30	- Aluminous cement	Free	Free	Free	Free
2523.90	- Other hydraulic cements	Free	Free	Free	Free
68.10	Articles of cement, of concrete or of artificial stone, whether or not reinforced				
	- Tiles, flagstones, bricks and similar articles				
6810.11	-- Building blocks and bricks	5%	Free	3%	3.9%
6810.19	-- Other				
6810.19.10	--- Floor and wall tiles	8%	Free	4.8%	16.8%
6810.19.50	--- Other	8%	Free	4.8%	3.9%
6810.20	- Pipes	9.8%	6.5%	5.8%	3.9%
6810.91	-- Prefabricated structural components for building or civil engineering	6.8-8%	4.5%-Free	4-4.8%	3.9%
6811.90	- Articles of asbestos cement, fibre cement or the like, n.e.s.	8%	5%	4.8%	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

n.e.s. Not elsewhere specified.

TABLE 1. CANADA, CEMENT PRODUCTION AND TRADE, 1988 AND 1989

Item No.		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production[1] (all forms)					
	Ontario	5 532 944	436 269	5 513 279	453 915
	Quebec	3 253 764	189 364	3 180 000	186 900
	Alberta	x	x	x	x
	British Columbia	x	x	x	x
	Manitoba	x	x	x	x
	Nova Scotia	x	x	x	x
	Saskatchewan	x	x	x	x
	Newfoundland	x	x	x	x
	New Brunswick	x	x	x	x
	Total	12 349 873	971 293	12 550 433	998 170
Imports				(Jan.-Sept.)	
2523.10	Cement clinker				
	Lebanon	65 369	2 719	40 581	1 906
	United States	3 313	148	32 772	1 892
	France	-	-	27 506	1 200
	Colombia	-	-	27 500	1 512
	Other countries	156 626	5 031		
	Total	225 308	7 898	128 359	6 511
2523.21	Portland cement, white whether or not artificially coloured				
	Greece	-	-	8 000	379
	United States	5 593	6 21	5 008	892
	Other countries	2 925	454	597	95
	Total	8 518	1 075	13 607	1 367
2523.29	Portland cement, n.e.s.				
	United States	304 052	18 302	258 064	14 603
	Spain	236 140	8 175	55 322	1 865
	Other countries	184 169	7 007	21 845	1 127
	Total	724 362	33 487	335 231	17 598
2523.30	Aluminous cement				
	United States	92 218	6 127	9 555	3 362
	Other countries	2 590	85	22	15
	Total	94 808	6 212	9 577	3 378
2523.90	Hydraulic cement, n.e.s.				
	United States	35 125	4 326	51 562	4 702
	Other countries	8 381	234	894	194
	Total	43 506	4 563	52 456	4 898
6810.11	Building blocks and bricks of cement, concrete or artificial stone				
	United States	..	8 868	..	4 165
	Other countries	..	2	..	142
	Total	..	8 871	..	4 308

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone				
	United States	. .	2 846	. .	4 175
	Italy	. .	2 132	. .	1 276
	Other countries	. .	488	. .	277
	Total	. .	5 471	. .	5 732
6810.20	Pipes of cement or concrete				
	United States	. .	6	. .	15
	Total	. .	6	. .	15
6810.91	Prefabricated structural components of buildings, etc. of cement/concrete, etc.				
	United States	. .	707	. .	1 081
	Other countries	. .	87	. .	99
	Total	. .	796	. .	1 180
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.				
	United States	. .	1 978	. .	2 234
	Other countries	. .	179	. .	475
	Total	. .	2 161	. .	2 713
Exports					
2523.10	Cement clinker				
	United States	331 796	11 565	108 649	3 934
	Total	331 796	11 565	108 649	3 934
2523.21	Portland cement, white whether or not artificially coloured				
	United States	76 234	9 353	31 058	2 940
	Other countries	2 408	283	346	189
	Total	78 642	9 637	31 404	3 131
2523.29	Portland cement, n.e.s.				
	United States	3 122 880	115 275	1 615 323	72 698
	Other countries	6 120	550	4 969	1 048
	Total	3 129 000	115 828	1 620 292	73 751

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
2523.30	Aluminous cement				
	United States	499	125	42 531	24
	Other countries	9	7	-	-
	Total	508	133	42 531	25
2523.90	Hydraulic cement, n.e.s.				
	United States	86 526	6 131	151 552	3 212
	Other countries	725	231	11 441	137
	Total	87 251	6 368	162 993	3 353
6810.11	Building blocks and bricks of cement, concrete or artificial stone				
	United States	..	3 441	..	1 994
	Other countries	..	140	..	61
	Total	..	3 585	..	2 056
6810.19	Tiles, flagstones and similar articles of cement/concrete or artificial stone				
	United States	..	5 770	..	1 239
	Other countries	..	833	..	64
	Total	..	6 608	..	1 304
6810.20	Pipes of cement or concrete				
	United States	..	747	..	53
	Other countries	..	1 631	-	-
	Total	..	2 378	..	53
6810.91	Prefabricated structural components of buildings, etc. of cement/concrete, etc.				
	United States	..	45 082	..	31 299
	Other countries	..	3 195	..	1 287
	Total	..	48 280	..	32 588
6810.99	Articles of cement, of concrete or of artificial stone, n.e.s.				
	United States	..	4 444	..	4 083
	Other countries	..	125	..	16
	Total	..	4 573	..	4 051

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments plus quantities used by producers.
p Preliminary; .. Not available; n.e.s. Not elsewhere specified; - Nil; x Confidential.
Note: Totals may not add due to rounding.

TABLE 2. CEMENT PLANTS, APPROXIMATE ANNUAL GRINDING CAPACITY, END OF 1988

Company	Plant	Wet(W) Dry(D) Pre-heater(x) Precal-ciner(c)	Fuel (Coal, Oil, Gas)	No. of Kilns	Grinding Capacity	Clinker Capacity
					(000 t/y)	
Atlantic						
Lafarge Canada Inc.	Brookfield, N.S.	D	C,O	2	485	458
North Star Cement Limited	Corner Brook, Nfld.	Dx	O	1	275	152
Atlantic Region Total				3	760	610
Quebec						
Lafarge Canada Inc.	Montreal East				600	-
Lafarge Canada Inc.	St. Constant	D	C,O,G	2	955	902
Ciment Québec Inc.	St. Basile	W,Dc	O,G	3	830	1 074
St. Lawrence Cement Inc.	Beauport	W	C	2	675	598
(Independent Cement Inc.)	Joliette	D	C,O	4	1 075	1 038
Quebec Region Total				11	4 135	3 612
Ontario						
Lafarge Canada Inc.	Woodstock	W	C,G	2	535	505
	Bath	Dx	C,G	1	1 000	943
Federal White Cement Ltd.	Woodstock	D	C,O,G	1	145	136
Lake Ontario Cement Limited	Picton	D,Dx	C,G	4	927	1 495
St. Lawrence Cement Inc.	Mississauga	W,Dc	C,O,G	3	1 600	1 767
St. Marys Cement Company	Bowmanville	W	C	2	910	600
	St. Marys	Dx	C,G	1	800	737
Ontario Region Total				16	5 917	6 183
Prairies						
Lafarge Canada Inc.	Fort Whyte, Man.				400	-
	Exshaw, Alta.	D,Dc	G	3	1 184	1 184
Inland Cement Limited-(CBR)	Winnipeg, Man.	W	G	1	370	350
	Regina, Sask.	D	O,G	1	215	200
	Edmonton, Alta.	Dc	G	1	780	726
Prairies Region Total				6	2 949	2 460
British Columbia						
Lafarge Canada Inc.	Kamloops	D	C,G	1	190	180
	Richmond	W	C,G	2	555	440
Tilbury Cement Limited-(CBR)	Tilbury Island	Dx	C,G	1	1 000	884
B.C. Region Total				4	1 745	1 504
Canada Total (9 companies)				40	15 506	14 369

Source: Market and Economic Research Department, Portland Cement Association.
- Nil.

TABLE 3. CANADA, CEMENT PLANTS, KILNS AND CAPACITY UTILIZATION, 1978-89

	Clinker-Producing Plants	Kilns	Approximate Cement Grinding Capacity[1]	Portland and Masonry Cement Production[2]	Clinker Exports[3]	Approximate Total Production[4]	Capacity Utilization
			(t/y)	(t)	(t)	(t)	(%)
1978	24	51	15 985 000	10 558 279	1 077 274	11 635 553	72
1979	24	51	15 985 000	11 765 248	1 530 537	13 295 785	83
1980	23	47	16 363 000	10 274 000	726 087	11 000 087	67
1981	23	48	16 771 000	10 145 000	524 006	10 669 006	64
1982	23	48	16 771 000	8 418 000	290 329	8 708 329	50
1983	23	49	17 900 000	7 870 878	404 793	8 275 671	46
1984	23	49	17 900 000	9 387 466	440 297	9 827 763	55
1985	23	49	17 900 000	10 192 442	676 596	10 869 038	61
1986	23	49	17 900 000	10 611 223	324 000	10 935 223	61
1987	20	40	16 600 000	12 603 164	767 338	13 370 502	81
1988r	20	40	15 506 000	12 349 873	331 796	12 681 669	82
1989p	20	40	15 506 000	12 550 433	178 491	12 728 924	82

Sources: Statistics Canada; U.S. Bureau of Mines; Portland Cement Association (PCA).

[1] Includes three plants that grind only. [2] Producers' shipments and amounts used by producers. [3] Imports to United States from Canada.

[4] Cement shipments plus clinker exports.

p Preliminary; r Revised.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1987 AND 1988

	Starts			Completions			Under Construction		
	1987	1988	% Diff.	1987	1988	% Diff.	1987	1988	% Diff.
Newfoundland	2 682	3 168	18.1	2 836	3 220	13.5	3 631	3 491	-3.9
Prince Edward Island	933	1 151	23.4	943	993	5.3	338	497	47.0
Nova Scotia	6 460	5 478	-15.2	6 488	5 793	-10.7	3 283	2 915	-11.8
New Brunswick	3 716	3 621	-2.6	3 944	3 798	-3.7	1 524	1 317	-13.6
Total (Atlantic Provinces)	13 791	13 418	-2.7	14 211	13 804	-2.9	8 776	8 220	-6.3
Quebec	74 179	58 062	-21.7	68 949	65 224	-5.4	28 974	21 372	-26.2
Ontario	105 213	99 924	-5.0	88 609	88 727	0.1	64 458	74 465	15.4
Manitoba	8 174	5 455	-33.3	7 627	5 621	-26.3	4 765	4 409	-7.5
Saskatchewan	4 895	3 856	-21.7	5 640	4 352	-22.8	2 457	1 885	-23.3
Alberta	10 790	11 360	5.3	9 334	11 201	20.0	4 331	4 407	1.8
Total (Prairie Provinces)	23 859	20 671	-13.4	22 601	21 174	-6.3	11 553	10 701	-48.2
British Columbia	28 944	30 487	5.3	23 606	27 603	16.9	13 986	16 694	19.4
Total Canada	245 986	222 562	-9.5	217 976	216 532	-0.7	127 747	131 452	2.9

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION BY TYPE[1], 1987-89

	1987	1988	1989
		($ millions)	
Building Construction[2]			
Residential	35 825	38 660	39 295
Industrial	3 244	3 560	3 678
Commercial	12 378	13 579	14 289
Institutional	4 314	4 512	4 967
Other building	2 147	1 415	2 848
Total	57 908	62 727	65 078
Engineering Construction[2]			
Marine	317	489	637
Highways, airport runways	5 433	5 633	5 987
Waterworks, sewage systems	2 304	2 920	3 333
Dams, irrigation	307	311	369
Electric power	3 616	4 824	5 616
Railway, telephones	2 922	3 051	3 475
Gas and oil facilities	6 030	7 450	7 447
Other engineering	3 135	3 310	3 255
Total	24 064	27 989	30 119
Total construction	81 971	90 715	95 197

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Actual expenditures 1987, preliminary actual 1988, intentions 1989. [2] Includes total value of new and repair work purchased.

Coal

1989

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SUMMARY

In 1989, the Canadian coal industry consolidated the market gains won in 1988 and prepared to meet the challenges of the 1990s. Preliminary statistics for the first nine months suggest that record production, consumption and export levels of 71, 55 and 33 million tonnes (Mt) respectively, would be achieved.

World coal trade remained tight as demand grew and supply was constrained by interruptions resulting from strikes in several major exporting nations. Growing international and domestic debates about the global warming issue raised new challenges for all fossil fuels, including coal.

Year-end negotiations indicated that traded coking and thermal coal prices should increase by about 5% on average, due to a relative balance in the demand and supply of coal and to record Japanese steel industry outputs and profits. While this will bring some relief to Canadian coal exporters who suffered through years of decreasing prices in the 1980s, they will need several years of price increases to return to a strong financial footing.

There was considerable coal activity within Canada. One new mine officially began commercial operations during the year in British Columbia, while work began on another new mine in Nova Scotia. A new mine near Edmonton, Alberta completed its first full year of operation, supplying a new 400 megawatt (MW) coal-fired power unit that officially came on-stream in October. Four other coal-fired stations with a total capacity of over 1200 MW are under construction, work on another one will begin in 1990, and the evaluation of a sixth unit will be ongoing throughout the upcoming year.

There were also structural and institutional changes in the coal industry in 1989. One coal mine was sold, one major western producer was restructuring, and the province of British Columbia replaced its existing coal royalty with a profit-based tax. These activities demonstrate that the Canadian coal industry is both growing and looking to the future with confidence.

DOMESTIC CONSUMPTION AND MARKETS

Preliminary statistics suggest that overall Canadian coal consumption in 1989 will likely experience a marginal increase over 1988 due to increased demands for coal for the generation of electricity in Alberta and Saskatchewan. The thermal power sector accounts for approximately 85% of the annual coal utilization in Canada, with most of the remainder consumed by the steel sector. Minor amounts are also used by industrial consumers. While the thermal power sector uses primarily Canadian coal, geographical and historical factors have led to the use of United States coal by central Canadian steel and industrial consumers.

Thermal coal demand in Nova Scotia changed little in 1989. Demand will, however, increase in the 1990s as two new coal stations come on-stream. The 150 MW Trenton unit is currently under construction and scheduled to be operational in 1991. Construction of the 150 MW Point Aconi station will begin in 1990 and could be completed by 1992. Other coal units were under consideration for later in the 1990s. Each new 150 MW unit will consume an additional 400 000 t/y of coal when working at full capacity. The Point Aconi station will use circulating fluidized bed technology which will capture most of the sulphur released during the combustion of the coal. A new mine is currently under construction in Pictou County and is scheduled to come on-stream in 1991 to supply coal for the Trenton station.

Thermal coal consumption grew marginally in New Brunswick in 1989 in response to increased demands for electricity. Demand should remain constant until a new coal-fired unit begins operation near Belledune. Preliminary work on this 400 MW unit began in late 1989, and commercial operation is scheduled for 1993. It will burn pulverized coal and be equipped with scrubbers, allowing it to burn eastern Canadian and other coals.

Coal consumption in Ontario decreased in 1989 primarily due to a reduction in the use of thermal coal for the generation of electricity. Consumption of both Canadian and United States coal in this market decreased almost equally during the year and forecasts suggest that coal use will remain fairly constant until the mid-1990s when the last unit at the Darlington nuclear station comes on-stream. Coal demand in the steel and industrial sectors was down marginally during 1989 reflecting a general economic slowdown in the latter half of the year.

Coal consumption also decreased in Manitoba where high water levels allowed for increased electricity generation from hydro facilities. Coal consumption in Manitoba, which is primarily used for peaking purposes in normal years, fell to nearly one third of the previous year's consumption level.

Coal use in Saskatchewan grew marginally in 1989 in response to small increases in electricity demand. Saskatchewan generates the majority of its electricity from coal and will increase its coal utilization with the addition of two new 300 MW coal units in the 1990s. The first unit of the new Shand station is currently under construction and scheduled for commercial operation in 1992. The second unit is scheduled for commercial operation in 1995.

Alberta remains the leading province in terms of thermal coal consumption. Overall demand was up primarily because of the operation of the new Genesee coal-fired generating station near Edmonton. Consumption at this station, during its first year of operation, approached one million tonnes, about two thirds of what it would normally consume when running for a full calendar year. Consumption of coal will continue to grow in Alberta with the start-up of the new 375 MW Sheerness II power station unit in 1990 and with the second 400 MW unit at Genesee scheduled for 1992. Additional power stations are planned for later in the 1990s.

EXPORTS

World coal trade grew in 1989 in response to buoyant steel industries and increasing demands for energy. The closure of some small, higher-cost export mines in Australia, together with strikes in Australia, the United States and, to a lesser extent, Canada, brought demand and supply more in balance than it has been in nearly a decade. Many exporters worldwide are producing at full capacity and inventories, both at ports and mines, are lower than normal. This, along with the fact that steel industry profits and output in Japan and certain other countries are at near record levels, is expected to result in price increases for coking and thermal coal exports for 1990. However, any near-term increases are unlikely to be enough to relieve the financial stress imposed on many exporters, as a result of six years of price decreases in the 1980s.

Canada is a major coal exporter ranking third in the world in coking coal. Despite some labour disturbances in three exporting mines, Canadian sales in 1989 are likely to exceed the 1988 record shipments. As has been the case in the last few years, exports in 1989 were divided about 80:20 between coking and thermal coals.

Japan remains Canada's largest coal customer, taking about two-thirds of total Canadian exports. Other important customers include South Korea and Brazil. Both coking and thermal coal are sold in Japan and Korea, while Brazil purchases only coking coal. Canadian coal is also sold in smaller volumes to a number of European countries and, more recently, into markets in the mid-western United States.

OUTLOOK

The last decade of this century will be critical for coal producers and consumers around the world. Several challenges are on the horizon which will help to determine the directions in which the industry will grow. Some of the challenges have been evolving for years while others are more recent.

The major problem of the 1980s, surplus capacity relative to demand, has at least temporarily been resolved. Demand and supply are in relative balance and indicators suggest this could continue, at least for the near term. Steel industries in the Asia-Pacific region are forecast to remain buoyant and prosperous in the early 1990s. Production is slated to decline slowly in Japan, but will continue to grow in South Korea and Taiwan. Steel industries in Latin America are also forecast to expand during this period. All of these increases in steel production will translate into increased international trade in coking coal.

Thermal coal demand for the generation of electricity is also forecast to increase in the Asia-Pacific region and in some countries in Europe throughout the 1990s. Much of the coal required to meet this demand would have to be imported and it is expected that most of the new mines to be developed in coal-exporting countries in the latter part of the next decade would be brought into production to meet this growing thermal coal demand. However, there is also some spare coal production capacity in Australia, the United States, South Africa and Canada that could be brought into production to satisfy incremental thermal coal demand, at least in the short term.

Exporters worldwide are, however, unanimous in the belief that prices for both thermal and coking coal will have to increase to encourage the development of any significant amounts of additional export coal capacity. These same exporters also argue that major subsidization of coal production in some European and Asian countries should be phased out. They suggest that even a 10% reduction in subsidized production could increase world coal trade by more than 20 Mt. This could have a significant impact on trade given that total coal exports in 1989 were just over 300 Mt.

There is also considerable subsidized production of coal in China, U.S.S.R., Poland and other Eastern Bloc countries. Changing political events in these countries could also increase world coal demand and trade.

Another significant challenge to coal, and to all other fossil fuels, is the growing debate over the issue of global warming and the release of carbon dioxide (CO_2) into the atmosphere. Debate surrounding this issue has grown in less than two years to become the major concern influencing predictions of future fossil fuel demand. While more information will need to be gathered prior to any major policy decisions at the national or international level, it is possible that this issue could have important implications for the future of all fossil fuels use.

Drawing on previous successes in developing new technologies to deal with land reclamation and acid rain, today's coal industries are reviewing research and development (R&D) priorities to deal with the global warming challenge. Initial activities are focussing on ensuring that the problem is properly understood and identifying new coal combustion technologies that could increase the efficiency of electrical generating stations. Attention is also being directed into ways in which CO_2 can be utilized in an environmentally acceptable manner. Possibilities include using CO_2 in enhanced oil recovery, injection into underground formations and chemical co-production.

Another new direction in coal R&D in Canada includes a study that will test the feasibility of transporting coal and petroleum condensates through pipelines. This project is designed to test the economics and environmental benefits of substituting coal for natural gas to produce steam for enhanced oil recovery.

The Canadian coal industry enters the 1990s with optimism. Production and exports are running at record levels, new mines have been recently developed and new power stations are being built. Domestic coal consumption is forecast to grow and exports are expected to increase.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. SUMMARY OF COAL SUPPLY BY TYPE AND VALUES, 1985–89

	1985		1986		1987		1988		1989p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
DOMESTIC[1]										
Bituminous										
Nova Scotia	2 800	169 000	2 955	178 000	2 925	179 000	3 545	216 000	3 580	207 000
New Brunswick	560	32 000	485	28 000	533	33 000	542	34 000	525	34 000
Alberta	7 841	311 000	7 619	297 000	7 202	239 000	9 558	299 000	10 560	335 000
British Columbia	22 994	1 090 000	21 140	974 000	21 990	948 000	24 941	974 000	24 920	977 000
Total	34 195	1 601 000	32 199	1 477 000	32 650	1 399 000	38 586	1 523 000	39 585	1 553 000
Sub-bituminous										
Alberta	16 871	137 000	17 331	143 000	18 537	150 000	19 910	160 000	20 500	168 000
Lignite										
Saskatchewan	9 672	108 000	8 281	101 000	10 020	92 000	12 148	122 000	10 915	115 000
Total	60 738	1 846 000	57 811	1 721 000	61 207	1 641 000	70 644	1 805 000	71 000	1 836 000
IMPORTED[2]										
Bituminous and anthracite briquettes	14 867	1 124 000	13 125	999 000	14 719	899 000	17 248	974 000	15 800	880 000
Total	75 605	2 970 000	70 936	2 720 000	75 926	2 540 000	87 892	2 779 000	86 800	2 716 000

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] F.o.b. mines. [2] Value at United States port of exit.

p Preliminary figures or estimates.

TABLE 2. PRODUCER'S DISPOSITION OF CANADIAN COAL, 1988

	Deliveries From					
Destination	Nova Scotia	New Brunswick	Saskatchewan	Alberta	British Columbia	Canada
			(kilotonnes)			
Newfoundland	-	-	-	-	-	-
Prince Edward Island	6	-	-	-	-	6
Nova Scotia	2 360	-	-	-	-	2 360
New Brunswick	51	542	-	-	-	593
Quebec	81	-	-	-	-	81
Ontario	-	-	2 227	1 845	848	4 920
Manitoba	-	-	978	-	37	1 015
Saskatchewan	-	-	8 936	1	34	8 971
Alberta	-	-	-	20 261	1	20 262
British Columbia	-	-	-	13	261	274
Total Canada	2 498	542	12 141	22 120	1 181	38 482
Shipments for export	1 047	-	7	7 348	23 760	32 162
Total	3 545	542	12 148	29 468	24 941	70 644

Sources: Statistics Canada; Energy, Mines and Resources Canada.
- Nil.

TABLE 3. SUMMARY OF COAL SUPPLY-DEMAND, 1978-89

Year	Canada Production				Imports				
	Bituminous	Sub-Bituminous	Lignite	Total	Anthracite	Bituminous	Total Available	Domestic Consumption	Exports
					(million tonnes)				
1978	17.1	8.3	5.1	30.5	0.3	13.8	44.6	31.7	14.0
1979	18.4	9.6	5.0	33.0	0.2	17.3	50.5	34.8	13.7
1980	20.2	10.5	6.0	36.7	0.3	15.5	52.5	37.3	15.3
1981	21.7	11.6	6.8	40.1	0.4	14.4	54.9	38.4	15.7
1982	22.3	13.0	9.5	42.8	0.3	15.5	58.6	41.5	16.0
1983	22.5	14.5	7.8	44.8	0.3	14.4	59.5	43.6	17.0
1984	32.1	15.4	9.9	57.4	0.2	18.1	75.7	48.6	25.1
1985	34.2	16.8	9.7	60.7	0.3	14.6	75.6	48.7	27.4
1986	32.2	17.3	8.3	57.8	0.4	12.7	70.1	44.6	25.9
1987	32.7	18.5	10.0	61.2	0.4	14.3	75.9	50.1	26.7
1988	38.6	18.9	12.1	70.6	0.4	16.8	87.8	54.4	31.7
1989p	39.6	20.5	10.9	71.0	0.5	14.5	86.7	55.0	33.2

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary.

TABLE 4. COAL USED BY THERMAL POWER STATIONS IN CANADA, BY PROVINCES, 1970-89

	Nova Scotia	New Brunswick	Ontario	Manitoba	Saskat-chewan	Alberta	Total Canada
				(000 tonnes)			
1970	548	113	7 696	503	1 969	2 951	13 780
1971	689	271	8 560	446	1 996	3 653	15 615
1972	663	281	7 599	410	2 145	4 113	15 211
1973	585	193	6 615	386	2 806	4 474	15 059
1974	606	292	6 721	132	2 902	4 771	15 424
1975	571	248	6 834	323	3 251	5 345	16 572
1976	730	207	7 612	979	3 521	5 996	19 045
1977	572	198	8 795	1 113	4 304	7 461	22 443
1978	771	151	9 097	341	4 585	8 029	22 914
1979	644	198	9 901	73	4 956	9 181	24 956
1980	1 052	315	10 779	240	4 972	10 424	27 782
1981	1 126	515	11 460	332	4 935	11 445	29 813
1982	1 300	548	12 484	184	5 897	13 242	33 656
1983	1 400	564	13 025	109	6 625	14 492	36 216
1984	1 974	610	13 413	163	7 925	16 123	40 208
1985	2 235	521	10 985	253	8 290	18 112	40 396
1986	2 137	469	9 172	111	6 786	17 719	36 394
1987	2 077	526	12 016	457	7 672	19 077	41 825
1988	2 266	678	13 079	780	8 637	20 538	45 978
1989p	2 500	700	12 500	300	8 800	21 600	46 400

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary.

TABLE 5. SUMMARY OF COAL DEMAND, 1984–89

	1984	1985	1986	1987	1988	1989p
	(000 tonnes)					
DEMAND						
Thermal Electric						
Canadian	29 935	32 563	30 035	33 932	37 451	38 100
Imported	10 273	7 833	6 359	7 893	8 527	8 300
Total	40 208	40 396	36 394	41 825	45 978	46 400
Metallurgical						
Canadian	–	52	243	290	16	–
Imported	6 542	6 210	5 891	6 019	6 247	6 200
Total	6 542	6 262	6 134	6 309	6 263	6 200
General Industry						
Canadian	813	582	655	594	672	580
Imported	1 136	1 416	1 375	1 416	1 477	1 400
Total	1 949	1 998	2 030	2 010	2 149	1 980
Exports						
Canadian	25 138	27 378	25 943	26 740	31 732	33 200
Total						
Canadian	55 886	60 575	56 876	61 556	69 871	71 880
Imported	17 951	15 459	13 625	15 328	16 251	15 900
Grand Total	73 837	76 034	70 501	76 884	86 122	87 780

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; – Nil.

TABLE 6. EXPORTS OF CANADIAN COAL BY DESTINATION

Exports	Jan.-Oct. 1989	Jan.-Oct. 1988
Australia	63	-
Belgium	6	47
Brazil	1 356	1 440
Chile	161	156
Denmark	422	235
Egypt	-	87
France	464	406
Italy	51	25
Japan	16 522	17 102
Mexico	-	55
Netherlands	512	345
Pakistan	206	126
Portugal	226	217
South Korea	4 459	4 149
Sweden	101	92
Taiwan	876	956
Turkey	-	51
United Kingdom	530	405
United States	1 017	862
West Germany	109	109
Total	27 081	26 865

Sources: Statistics Canada and Energy, Mines and Resources Canada joint survey, Coal.
- Nil.

TABLE 7. CANADA, COAL PRODUCTION, IMPORTS, EXPORTS AND CONSUMPTION, 1984–89

	Production	Imports	Exports	Domestic Consumption
			(000 tonnes)	
1984	57 402	18 352	25 138	48 699
1985	60 738	14 867	27 378	48 556
1986	57 811	13 125	25 943	44 558
1987	61 209	14 719	26 740	50 144
1988	70 644	17 248	31 732	54 390
1989p	71 000	15 800	33 200	54 580

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary figures or estimates.

TABLE 8. CANADA, COKE PRODUCTION AND TRADE, 1978–88

	Production		Imports		Exports	
	Coal	Petroleum	Coal	Petroleum	Coal	Petroleum
			(tonnes)			
1978	4 967 664	1 014 076	553 349	973 985	82 620	134 762
1979	5 775 141	1 105 433	520 534	980 657	189 555	125 416
1980	5 249 744	1 156 444	626 923	908 322	79 927	150 200
1981	4 659 007	1 098 397	653 645	935 929	67 642	200 149
1982	3 999 117	1 083 129	453 915	650 810	14 392	104 897
1983	4 120 002	986 730	576 649	759 954	1 601	65 323
1984	4 900 478	1 072 983	660 257	886 734	10 654	55 300
1985	4 683 770	1 099 808	369 224	866 530	21 944	45 968
1986	4 552 532	765 867	432 730	941 314	9 126	46 554
1987	4 636 629	1 039 556	599 015	964 949	70 094	53 118
1988	4 663 441	1 739 682	568 063	1 347 152	19 685	48 840

Cobalt 1989

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Western world cobalt production during the first half of 1989 was 8647 t compared to 10 594 t during the same period in 1988, based on figures published by the Cobalt Development Institute (CDI). The decline was mainly due to a 30% reduction in output from Zaire's copper-cobalt mines, the world's largest producer of cobalt and, to a lesser extent, changes in Zambian and Canadian operations.

Total 1989 cobalt output in the western world was estimated at 19 300 t compared to 20 558 t in 1988. According to industry sources, consumption has increased by 4.5% to 22 000 t; the major increases were in the aerospace industry and the chemical sector. This shortfall in production has resulted in cobalt inventories being reduced to more manageable levels.

Under these conditions, cobalt markets remained relatively stable during 1989, a continuation of the situation from 1988 after the joint introduction of producer price by the two leading African cobalt producers, Zaire and Zambia. With an established producer price, a built-in discounting system and a marketing strategy of selling directly to end-users, the impact of the dealer trading activity on the cobalt market has been significantly reduced.

CANADIAN DEVELOPMENTS

Canadian cobalt production in 1989 was an estimated 2337 t valued at $45.5 million compared to 2398 t at $45 million for 1988. A drop in cobalt production from Manitoba operations was partly offset by an increase from Ontario mines.

Inco Limited and Falconbridge Limited, which produce cobalt as a by-product of nickel-copper operations, are Canada's two largest producers; Sherritt Gordon Limited of Fort Saskatchewan, Alberta also produces cobalt for Inco from toll-refining and from imported materials.

Sherritt's cobalt refinery output dropped significantly in 1989 due to a cut-back in production, and also because of unexpectedly high arsenic and other contaminant levels in the nickel-cobalt feed from Inco's Thompson mines.

Sherritt's ten-year toll-refining contract with Inco expired at the end of 1989 and will not be renewed. Although Sherritt has acquired nickel feed in contracts with two new Canadian nickel producers, the Namew and Redstone mines, production by Sherritt is expected to remain at lower levels in future years because of the low cobalt content of these ores.

In 1989, Inco announced that it planned to develop a major, new mine in the Sudbury area, the McCreedy East, at a cost of $179 million. This new mine, expected to come on-stream in 1993 and reach full production in 1996, is the second major mine development project undertaken by Inco in the last two years. Late in 1988, the company announced a $100 million project at Thompson, Manitoba which includes the development of the South Pit. Production from the South Pit is expected to start in 1991/92. The addition of these two mines should make up for the loss of cobalt production due to exhaustion of reserves at the Thompson Open-Pit.

Also in 1989, ownership of Falconbridge was acquired by Noranda Inc. and Trelleborg AB of Sweden in a 50:50 joint partnership arrangement. As for cobalt, Falconbridge will continue to recover the metal from its Sudbury matte and feedstock from other sources at its Kristiansand, Norway refinery.

Sherritt Gordon was awarded a contract by the Defense Logistics Agency (DLA) in October 1989 to upgrade cobalt materials from the U.S. National Defense Stockpile. The contract for a total of 186 t of cobalt materials represents about 45% of the stockpile DLA originally sought to upgrade. Sherritt will use Norwegian-produced lower-grade material to upgrade to a 99.9% B-grade cobalt, suitable for use in superalloys and jet aircraft engine parts.

Geddes Resources Limited conducted additional drilling on its Windy Craggy deposit in northwestern British Columbia. Surface and underground drilling has confirmed previously defined ore reserves. Proven reserves were reported to be 118 Mt of 1.9% copper, 0.08% cobalt, 0.19 oz./t gold and 3.26 oz./t silver. The company was to have completed a pre-feasibility study by late 1989. Geddes Resources plans to conduct further drilling between the North and South zones to see if they form a giant U-shape fold.

Placer Dome Inc. of Vancouver optioned a cobalt-bearing massive sulphide prospect adjacent to tidewater near Juneau, Alaska. The Dream project is located in the same geological environment as those of the Windy Craggy deposit and BP Minerals Limited's Greens Creek deposit.

At the Discovery zone of the Dream project, continuous chip sampling along a 200-foot outcrop returned an average ore grade of 0.6 oz./t gold and 0.37% cobalt. Based on an agreement in principle, Placer Dome can earn a 60% interest from International Curator Resources Ltd. (ICR) by spending $2 million on exploration and development over three years, and by purchasing $200 000 worth of ICR shares.

WORLD DEVELOPMENTS

Cobalt production by Zambia Consolidated Copper Mines Limited (ZCCM) of Zambia, the world's second largest producer, was expected to decline to 4500 t in 1989 from the 1988 high of 4997 t due to a four-week smelter shutdown during May and June. Production at Générale des Carrières et des Mines-Exploitation (GECAMINES-EXPLOITATION) of Zaire declined from 10 032 t in 1988 to an estimated output of 9000 t in 1989. The fall in production in Zaire was reported to stem from equipment shortages, operational problems and rail transport delays.

According to the CDI published statistics, the drop in combined production in Zaire and Zambia during the first half of 1989 has reduced the share of Central Africa's western world cobalt supply to 68.5% in 1989 from 75.2% in the corresponding period of 1987.

The Soviet Union is also a major producer of cobalt with part of its feed coming from Cuba. Annual output is estimated to be at about 5000 t. In 1989, the Soviet Union was reported to have made cobalt shipments to the western world for the first time.

In late 1989, Brazil's Cia Niquel Tocantins announced that it had commenced production of electrolytic cobalt at its São Miguel Paulista nickel plant in the state of São Paulo. This is Brazil's first cobalt producer. The company planned to increase its cobalt production to 600 t/y by 1991 from the current 20 t/m, making Brazil a net cobalt exporter.

Noranda Minerals Inc. and M.A. Hanna Company were to sign agreements with Blackbird Metals Inc. for the sale of the Blackbird cobalt mine in Idaho. Although details have not been released, the deal was to have been completed at the end of 1989. In 1988, Blackbird Metals signed a US$7 million agreement with the Idaho state government to settle claims involving past pollution at the mine site. The company intends to build a 3000 t/y refinery to produce high-purity cobalt metal.

Japan continued to acquire cobalt as part of its rare metal stockpile program. The total stockpile will be equivalent to 60 days of supply, based on the 1986 consumption level. In March 1988, reported stockpile was equivalent to 44 days, of which the government's share was 30.8 days and the private sector's share 13.2 days. The acquisition of cobalt will continue until the goal is reached in 1991.

Over the last few years, there has been an increase in requirements for higher-quality cobalt metals, especially from the aerospace sector for high-performance and high-temperature jet engines, as well as from the chemical industry for low-impurity cobalt for the manufacture of magnetic coatings used in high-resolution video and audio tapes.

More stringent specifications and an increasingly complex line of products have raised costs leading the industry, especially the cobalt producers, to call for the establishment of international quality standards. In 1988, the two leading African producers requested such standards for five grades of cobalt for various applications. These standards would specify mininum cobalt content and maximum levels of nickel and 22 other trace impurities. At the end of 1989, response from consumers had been limited. Producers anticipate that further discussions could be conducted under the auspices of the CDI so that draft specifications could be drawn up.

PRICES

The cobalt market was stable and the spot market quiet during the early part of 1989. Prices hovered in the US$7.30 to US$7.60/lb. range. Zaire's purchase of cobalt materials from France's stockpile helped to maintain this market stability.

In May, following record orders for new aircraft, coupled with growing concerns over a possible supply disruption from Zaire and a one-month smelter shutdown for maintenance in Zambia, the cobalt price increased to US$7.90/lb.

During the last quarter, however, cobalt prices dropped back to between US$7.30 and US$7.50/lb. as a result of lower demand from paint driers due to slower auto sales, and the arrival of U.S.S.R. cobalt on the market.

The producer price, on the other hand, remained at US$8.40/lb. for cathode throughout 1989, the level the two major African producers, GECAMINES-EXPLOITATIONS and Metal Marketing Corp. of Zambia Ltd. (Memaco), set in November 1988. Towards year-end, unconfirmed reports were that these two producers have decided to maintain this official producer price and the same discount rates during 1990.

USES

One of the major uses for cobalt is in superalloys where it improves the strength, wear and corrosion resistance characteristics of alloys at elevated temperatures. The major use of cobalt-based superalloys is in turbine blades for aircraft jet engines and gas turbines for pipeline compressors. Cobalt-based superalloys normally contain 45% or more cobalt, while nickel and iron-based superalloys contain 8 to 20% cobalt.

Although the demand for cobalt in the production of magnets has been declining in recent years, this is still an important application. Consumption of cobalt in this sector is now less than one half of the 1970 level. Neodymium-iron-boron magnets have become an important substitute for samarium-cobalt although not as successful as originally anticipated. The specific advantages of cobalt-bearing magnets in certain applications will probably help maintain cobalt consumption in this sector at about current levels.

Cobalt-based alloys are also used in specialized applications such as machining very hard materials or where high-abrasion resistance qualities are required. In such applications, the most important group of cobalt-based alloys is the stellite group, containing cobalt, tungsten, chromium and molybdenum as principal constituents. Hard-facing or coating of tools with cobalt alloys provides greater resistance to wear, heat, impact and corrosion.

Cobalt metal powder has an important application as a binder in the production of cemented tungsten carbides for heavy-duty and high-speed cutting tools.

In chemical applications, cobalt oxide is an important additive in paint, glass and ceramics. Cobalt is also used to promote the adherence of enamel to steel for applications such as appliances, and steel to rubber for manufacturing of steel-belted tires. A cobalt-molybdenum-alumina compound is used as a catalyst in hydrogenation and for petroleum desulphurization.

OUTLOOK

Steady demand and the loss of some refinery production during 1989 worked to the benefit of the cobalt industry by lowering inventories to a more manageable level, leading to a better balance between supply and demand.

As the two major African producers continue to maintain a tight rein on their production through long-term contracts, the spot market will continue to be a less significant factor. If these producers can maintain prices, stable market conditions can be expected to continue into the 1990s.

Cobalt production in 1990 could be significantly higher if Zaire returns to its normal level of production and if the Brazilian operation reaches capacity. Output could be further increased if some previous producers such as the Blackbird mine in the United States and the Nonoc mine in the Philippines are brought back on-stream.

However, both of these latter two mines are unlikely to provide much help in the near term as their startup will have to rely on a long-term strong cobalt market. For Canada, cobalt output could rise if the Windy Craggy deposit is brought into production.

Consumption of cobalt in the near term is anticipated to remain strong, especially in the superalloy sector as record orders for new passenger aircraft to replace an aging fleet will extend at least into the mid-1990s. The use of cobalt in the chemical sector is expected to continue at current levels. Finally, the samarium-cobalt magnet market should stabilize as substitution by neodymium-boron-iron has not been as successful as originally anticipated.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

		Canada			United States
Item No.	Description	MFN	GPT	USA	Canada
2605.00.00	Cobalt ores and concentrates	Free	Free	Free	Free
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides				
2822.00.10	--- Cobalt hydroxides	Free	Free	Free	2¢ kg
2822.00.90	--- Other	9.8%	Free	5.8%	2¢ kg
2827	- Other chlorides				
2827.34.00	-- Of cobalt	12.5%	8%	7.5%	3.3%
2833.29.00.40	Cobalt sulphate	9.2%	6%	5.5%	1.1%
2836.99.00.20	Cobalt carbonates	12.5%	8%	7.5%	3.3%
2915.23.00	Cobalt acetates	12.5%	8%	7.5%	3.3%
81.05	Cobalt mattes and other intermediate products of cobalt metallurgy; cobalt and articles thereof, including waste and scrap				
8105.10	- Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; waste and scrap; powders				
8105.10.10	--- Mattes and other intermediate products; unwrought cobalt, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	6.1%	4.4%
8105.10.20	--- Unwrought cobalt, not alloyed; powders, not alloyed	Free	Free	Free	Free
8105.90	- Other				
8105.90.10	--- Bars and rods, not alloyed	6.8%	Free	4%	4.4%
8105.90.90	--- Other	10.2%	6.5%	6.1%	4.4%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, COBALT PRODUCTION AND TRADE, 1988 AND 1989 AND CONSUMPTION, 1986–88

Item No.		1988		1989p	
		(kilograms)	($000)	(kilograms)	($000)
Production[1] (all forms)					
Ontario		1 944 160	36 508	1 982 000	38 551
Manitoba		454 185	8 582	354 000	6 957
Total		2 398 345	45 090	2 337 000	45 507
Exports				(Jan.-Sept.)	
2605.00	Cobalt ores and concentrates				
	United States	98 335	445	20 605	73
	Total	98 335	445	20 605	73
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides				
	United Kingdom	419 266	7 809	262 736	5 357
	South Korea	-	-	25	1
	United States	534 057	3 008	11	. . .
	Taiwan	95	3	-	-
	Total	953 418	10 820	262 772	5 358
2915.23	Cobalt acetates	-	-	11 420	76
81.05	Cobalt mattes and other intermediate products of cobalt metallurgy; cobalt and articles thereof, including waste and scrap				
8105.10	- Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; waste and scrap; powders				
	Norway	961 517	14 962	947 890	16 423
	United States	1 421 157	21 684	974 376	15 694
	United Kingdom	226 649	4 266	169 606	2 697
	Other countries	197 206	5 494	158 764	3 332
	Total	2 806 529	46 406	2 250 636	38 146
8105.90	- Other				
	United States	226 275	4 207	21 344	418
	United Kingdom	17 603	373	12 802	307
	Other countries	8 818	392	35 148	276
	Total	252 696	4 972	69 294	1 001
Imports					
2605.00	Cobalt ores and concentrates				
	United States	19 073	20	72	1
	Total	19 073	20	72	1
2822.00	Cobalt oxides and hydroxides; commercial cobalt oxides				
2822.00.10	---Cobalt hydroxides				
	Finland	13 491	199	7 750	124
	Belgium	2 713	52	6 681	95
	United States	3 628	54	-	-
	Other countries	3 136	54	-	-
	Total	22 968	359	14 431	220

Cobalt

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(kilograms)	($000)	(kilograms)	($000)
Imports (cont'd)					
2822.00.90	---Other				
2822.00.90.10	----- Cobalt oxides				
	United States	4 220	80	7 481	131
	Belgium	5 000	85	5 100	92
	United Kingdom	-	-	250	5
	Total	9 220	165	12 831	228
2822.00.90.20	----- Commercial cobalt oxides				
	United States	4 124	57	39	. . .
	Other countries	235	1	-	-
	Total	4 359	58	39	. . .
2827.34.00	-- Cobalt chlorides				
	United States	47 986	166	176 447	672
	West Germany	54 000	382	1 676	23
	Belgium	18 000	124	20	. . .
	Total	119 986	674	178 143	696
2833.29.00.40	Cobalt sulphate				
	United States	83 735	347	23 010	164
	Other countries	3 589	18	15 941	78
	Total	87 324	365	38 951	242
2836.99.00.20	Cobalt carbonates				
	United States	36 525	286	19 235	293
	Other countries	4 039	64	788	12
	Total	40 564	350	20 023	305
2915.23.00	Cobalt acetates				
	United States	822	8	10 565	73
	United Kingdom	27	. . .	245	2
	Total	849	8	10 810	76
8105.10	- Cobalt mattes and other intermediate products of cobalt metallurgy; unwrought cobalt; waste and scrap; powders				
8105.10.10	--- Mattes and other intermediate products; unwrought cobalt, alloyed; waste and scrap; powders, alloyed				
8105.10.10.10	----- Unwrought cobalt; powders; mattes and other intermediate products				
	United States	39 083	1 591	23 033	736
	Other countries	2 746	91	1 177	48
	Total	41 829	1 682	24 210	784
8105.10.10.20	----- Waste and scrap				
	Zaire	3 368	50	268 800	4 503
	Switzerland	87 131	1 364	-	-
	Other countries	60 513	75	30 502	210
	Total	151 012	1 489	299 302	4 713

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(kilograms)	($000)	(kilograms)	($000)
Imports (cont'd)					
8105.10.20	---Unwrought cobalt, not alloyed; powders, not alloyed				
8105.10.20.10	----- Unwrought cobalt				
	Zaire	235 200	3 530	67 200	1 104
	Norway	9 916	184	6 370	108
	Other countries	155 756	1 994	251	8
	Total	400 872	5 708	73 821	1 220
8105.10.20.20	----- Powders				
	United States	32 348	794	37 309	986
	Norway	-	-	69 238	249
	Other countries	124	3	3 318	125
	Total	32 472	797	109 865	1 360
8105.90	- Other				
8105.90.10	---Bars and rods, not alloyed				
	United States	5 371	253	520	55
	Other countries	290	8	534	18
	Total	5 661	262	1 054	74
8105.90.90	---Other				
	United States	52 021	3 178	37 455	2 543
	Japan	929	70	-	-
	Other countries	1 174	40	2 175	81
	Total	54 124	3 288	39 630	2 624

	1986	1987	1988p
		(kilograms)	
Consumption[2]			
Cobalt contained in:			
Cobalt metal and metallic compounds	24 901	46 029	69 153
Cobalt pigments, feed and ground coat frit	11 658	13 622	15 342
Cobalt salts and driers and other uses[3]	59 514	60 543	74 795
Total	96 073	120 194	159 290

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Production (cobalt content) from domestic ores. [2] Available data reported by consumers. [3] Other uses includes glass and chemicals.

p Preliminary; - Nil; . . . Amount too small to be expressed.

Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, COBALT PRODUCTION, TRADE AND CONSUMPTION, 1975 AND 1980-88

		Exports		Imports		
	Production[1]	Cobalt metal	Cobalt oxides and hydroxides	Cobalt ores[2]	Cobalt oxides and hydroxides[3]	Consumption[4]
			(tonnes)			
1975	1 354	431	561	. .	. .	123
1980	2 118	325	1 091	2	26	105
1981	2 080	677	601	24	20	101
1982	1 274	585	212	2	30	81
1983	1 410	885	192	45	30	101
1984	2 123	1 487	373	14	27	113
1985	2 067	1 551	268	36	192	101
1986	2 297	1 805	374	20	31	96
1987	2 490	1 875	440	45	38	120
1988	2 398	3 059	953	19	37	159p

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Production from domestic ores and cobalt content of intermediate products exported, including cobalt content of Inco Limited and Falconbridge Limited shipments to overseas refineries. [2] Cobalt content. [3] Gross weight. [4] Consumption of cobalt in metal, oxides and salts.

p Preliminary; . . Not available.

TABLE 3. WESTERN WORLD COBALT PRODUCTION BY PRIMARY PRODUCERS, 1986–89

	1986	1987	1988	1989[1]
		(tonnes)		
Falconbridge Limited	1 574	1 575	1 951	983
Gecamines Commerciale	14 478	12 000	10 032	3 713
Inco Limited	1 341	1 584	1 410	671
Outokumpu Oy	1 349	1 234	1 132	670
Sherritt Gordon Limited	885	920	927	338
Sumitomo Metal Mining Co. Ltd.	859	126	109	53
Zambia Consolidated Copper Mines Limited	4 344	4 490	4 997	2 219
Other	481	-	-	-
Total	25 311	21 929	20 558	8 647

Source: Cobalt Development Institute.

[1] January to June.

- Nil.

Columbium

1989

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Western world production of columbium in 1989 grew by 4% over 1988 to 14 625 t of contained columbium. All three major world columbium producers, one in Canada and the other two in Brazil, continued to operate at or near record production levels in 1989.

The market for columbium remained strong in 1989; demand for columbium for steelmaking was up by 2% over 1988. For the three major markets, consumption in Europe and the United States remained at about 1988 levels while most of the consumption increase was recorded in Japan.

Despite a decline in steel exports by Japan, especially in columbium containing line-pipe, an increase in domestic demand for columbium in the automotive sector, coupled with higher capital spending, has more than made up for these export losses.

Demand by the superalloy industry, another important end use of columbium, declined significantly in 1989 despite the strong performance of the aerospace industry. During the first half of 1989, demand for columbium by the U.S. superalloy industry was reported to have declined by over 30%.

Prices for columbium products during 1989 increased by 7-11%. This is the second price increase in eight years; the first was in March 1988. Historically, columbium prices have been remarkably stable as compared to other alloy-steel additives.

CANADIAN DEVELOPMENTS

Columbium is produced in Canada at the Niobec mine located at St-Honoré, Quebec. Production in 1989 was 3503 t of Cb_2O_5 contained in concentrates an increase of 4% over the 1988 figure of 3367 t. Ongoing exploration has helped the mine maintain its reserves which, in 1989, were reported to be 11 952 000 t grading 0.656% Cb_2O_5. This indicates a 76% replacement of mined reserves.

The Niobec mine is jointly owned by Cambior inc. and Teck Corporation, each with a 50% interest. In terms of management responsibility, Teck operates the mine and Cambior markets the output.

Niobec is the world's only supplier of pyrochlore concentrate as the two other major producers, both located in Brazil, sell only upgraded columbium products. The Niobec product is sold under long-term contracts to converter-agents such as Murex Ltd. in the United Kingdom, Metallurg Inc. in the United States, and Mitsui & Co., Ltd. in Japan.

Ferrocolumbium sales of Canadian origin have increased significantly during the last two years following a federal government decision allowing duty-free entry of ferrocolumbium made from Canadian columbium ores and concentrates. As Canada presently does not have a domestic ferrocolumbium producer, concentrates are shipped to the United States for conversion before re-entering Canada.

Prior to the decision, ferrocolumbium imports were subject to a 4% duty with the exception of those imports entering Canada under the General Preferential Tariff. Ferrocolumbium from Brazil, generally classified under this category, is not subject to duty.

In other Canadian developments, Hecla Mining Company of Canada Ltd. completed a feasibility study in 1989 including pilot plant testing, marketing studies and environmental assessment, on the Thor Lake property. The property, located about 100 km southeast of Yellowknife, Northwest Territories, is owned by Highwood Resources Ltd.

This deposit is a multimineral occurrence with beryllium, yttrium, columbium, tantalum, zirconium and rare-earth elements being the major economic minerals. Initial indications were that beryllium could be produced economically and that columbium and tantalum could be produced as by-products at a later date.

Under an agreement with Highwood Resources, Hecla can acquire a 50% interest in the property by bringing it into commercial production. The agreement is to expire in February 1990. Hecla is presently reviewing the results of its feasibility study, with a view to making a final decision on the property.

WORLD DEVELOPMENTS

In Brazil, the Araxá mine of Companhia Brasileira de Metalurgia e Mineração S.A. (CBMM), the world's dominant producer, continued to operate at near record levels in 1989 with its adjacent ferrocolumbium plant. Total ferrocolumbium sales in 1989 were up by 5% to 13 538 t, of which 89% was destined for exports, while sales of high-purity columbium oxide decreased by 6% to 674 t.

CBMM's principal ferrocolumbium markets during the year were as follows: Europe, 34%; Japan, 22%; the United States, 21%; Canada, 3%; the U.S.S.R., 4%; Brazil, 11%; and elsewhere, 5%. The company reported that in 1989 Japan had become its second largest market after Europe, surpassing the United States.

CBMM, which supplies about 70% of the world's requirements, is 55% owned by the Moreira Salles Group of Brazil and 45% by Molycorp, Inc. of the United States. Besides producing a standard grade ferrocolumbium, which represents about 94% of its total output, CBMM also produces a wide range of high-purity columbium products including vacuum-grade ferrocolumbium, nickel-columbium, columbium metal, and high-purity and optical-grade columbium oxides.

In May 1989, CBMM initiated columbium metal production with an electric beam furnace at Araxá. The new plant, with a capacity of 40 t/y of columbium metal ingot, was installed at a cost of $US7 million. The company also erected a new oxide plant to replace the existing plant which was shut down in early 1989. The new oxide plant commenced production in May at an annual capacity of 2200 t of columbium oxide.

Over 50% of CBMM's production in 1989 was sold through its subsidiary, Niobium Products Company Ltd., with offices in Pittsburg and Dusseldorf. Its standard grade ferrocolumbium is also sold through firms such as Molycorp, Inc., Metallurg Group, Kloeckner and Co., Promsyrioimport of the U.S.S.R., and Nissho Iwai Corporation of Japan.

Mineração Catalão de Goiás S.A., the other Brazilian columbium producer, is a joint venture between Anglo American Group (70%) and Unamina - Empreendimentos Gerais Ltda. (30%). The mine, located at Ouvidor, is about 20 km from the town of Catalão in the State of Goiás. Mineração Catalão production, 2800 t/y of ferrocolumbium, is all destined for export. The mine was reported to be operating at capacity during 1989.

Mamore Mineração e Metalurgia SA, a unit of Paranapanema SA, was to have begun production of columbium and tantalum oxides in 1989 at its Pitinga tin mine in the Amazon region. The new processing plant, with an annual production capacity of 970 t of oxides, is designed to recover oxides of columbium and tantalum in a ratio of 10:1 as by-products of tin mining. At year-end, no columbium production had been reported. Paranapanema is the largest tin producer in Brazil.

West Coast Holdings Ltd. of Australia continued development at its Brockman rare-metal deposit, located in the Kimberley region of Western Australia. In addition to columbium and tantalum, the deposit is also rich in yttrium, zirconium, gallium, hafnium and rare earths. A feasibility study, including pilot plant test work, is being carried out in the United Kingdom with commercial production of refined columbium oxide planned for 1991.

Gabon has discovered a large, high-grade pyrochlore deposit, second only to the Araxá deposit. This deposit, located 40 km east of Lambarene along the Trans-Gabon Railway, is reported to contain 750 000 t of Cb_2O_5 and 600 000 t of rare earths and yttrium oxides.

USES

The steel industry is the largest consumer of columbium, and the addition of columbium, about 85% of which is in the form of ferrocolumbium, is used as a grain refiner and precipitation strengthener in high-strength low-alloy (HSLA) steels, stainless steels and heat-resisting steels.

Although the quantity of contained columbium may be as low as 0.02% in HSLA steels, the yield strength and mechanical properties of the resulting steel are significantly improved. These characteristics are particularly important in applications such as large-diameter pipelines, automotive components, structural applications and drilling platforms.

In the manufacture of high-alloy and stainless steels, columbium is used to impart resistance to corrosion at elevated temperatures, a property of particular importance in applications such as petroleum-processing plants, heat exchangers for severe chemical environments and acid pressure vessels. The addition of columbium to stainless steels provides the corrosion resistance through the formation of columbium carbide which inhibits intergranular corrosion.

High-purity columbium pentoxide is used mainly in superalloys for turbine and jet engines, which has traditionally been the second largest application after steels. The addition of columbium to cobalt- and nickel-based superalloys improves the high temperature characteristics of these alloys. In addition, columbium-based alloys containing tantalum, tungsten and zirconium are used in the aeronautic and nuclear industries.

Special high-purity columbium pentoxide is produced for optical applications. Additions of columbium pentoxide to optical glass creates a high refractive index material thereby allowing production of thin lenses for eyeglasses and lenses for specialty applications. Some specialty lenses, such as those used in cameras and photocopiers, contain up to 30% columbium pentoxide.

Columbium becomes superconductive below 9.15K in liquid helium. At present, the only major commercial use of columbium superconductor is in the production of Nuclear Magnetic Resonance (NMR) scanners. Other such applications include electronic devices and magnetic coils. Of the superconductive alloys, columbium-titanium has been the most widely used material although columbium-tin is preferred where very high magnetic fields are required.

Some of the major applications proposed for low-temperature columbium superconductors include particle accelerators, fusion reactors, high-speed magnetic levitation trains, magnetohydrodynamic power generators and underground energy storage.

In 1989, the President of the United States approved initial funding of US$225 million to start construction of the Superconducting Super Collider (SSC) in Texas. The US$6 billion SSC, 80 km in circumference, is to be located 40 km south of Dallas, and will require about 420 t of columbium metal over a five-year period.

PRICES

Columbium prices are generally higher as a result of continuing strong demand for the metal. On June 1, CBMM raised its price for its standard-grade ferrocolumbium from US$6.00 to $6.58/lb., and from US$7.14 to $7.64/lb. for its high-purity columbium oxide. List prices for high-purity ferrocolumbium and nickel-columbium posted by Cabot Corporation, Shieldalloy Corporation, and Reading Alloys, Inc., were quoted at US$17.50 and US$19.50/lb. Cb contained, respectively.

Canada's pyrochlore price was not published during the year, but was reported to have increased by about the same percentage as the standard-grade ferrocolumbium. The columbite market was less rosy. Spot columbite ore was quoted at US$3.00 to $3.50/lb.

OUTLOOK

Columbium consumption will likely remain strong during the first half of 1990. During the second half, however, industry experts predict a slowdown in columbium demand, particularly by the automotive sector in Europe and the United States.

For oil industry applications, the drastic cutback in imports of large-diameter line-pipe by the U.S.S.R. is likely to be made up by an increase in line-pipe production by Canada and the United States. The expected increase in pipeline construction projects in these two countries during the next three to five years is going to have a positive impact on the columbium market.

The growth in global consumption of columbium is projected to be around 2% per year, dampened by the following factors. First, despite the optimism of possibly two supercolliders being built in the next decade, there is a lack of major new applications on the horizon. Secondly, growth of columbium steel as a replacement for carbon steel has been slow, particularly in developing countries.

Due to the ease of columbium's substitution for other alloy additives such as vanadium, molybdenum and titanium in some major applications, high vanadium prices coupled with a stable columbium market during the last few years have resulted in a fair amount of substitution by columbium for vanadium. During 1989, however, the vanadium market faltered and prices declined dramatically. Low vanadium prices could result in reverse substitution of vanadium for columbium in the coming years.

With regard to superconductors, magnetic resonance imaging (MRI) remains the only large commercial application at this stage and its growth is inhibited by the high capital cost of MRI.

The proposed construction of two super-colliders, the SSC and one in Europe, if built during the same period, could have an important impact on the columbium metal market. However, total demand, estimated at 1200 t spread over five years, is fairly small in relation to total annual columbium consumption.

On the supply side, there will be excess capacity well into the next decade. Although Brazil, with its abundant proven reserves and newly found resources, will continue to be the dominant supplier for the foreseeable future, other countries such as Gabon, Zaire, China, and Greenland could become important suppliers and competitors to Brazil.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2615.90.00.10	Niobium ores and concentrates	Free	Free	Free	Free
8112.91.10.40	Niobium (columbium), unwrought metal, not alloyed; powders, not alloyed	4%	Free	2.4%	3.9%
8112.91.20.14	Niobium (columbium), unwrought metal, alloyed; waste and scrap; powders	10.2%	6.5%	6.1%	3.9%
8112.99.90.40	Niobium (columbium), other	10.2%	6.5%	6.1%	4.4%
7202.93.00	Ferro-niobium	10.2%	6.5%	6.1%	4.0%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, COLUMBIUM (NIOBIUM) PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975 AND 1980–1988

	Production[1] Cb_2O_5 Content	Imports Primary Forms and Fabricated Metals Columbium	Imports Primary Forms and Fabricated Metals Columbium Alloys	Exports[2] Columbium Ores and Concentrates to United States	Consumption[4] Ferrocolumbium and Ferro-tantalum-columbium (Cb and Ta-Cb Content)
			(kilograms)		
1970	2 129 271	. .	. .	576 227	132 449
1975	1 661 567	. .	. .	9 682	215 910
1980	2 462 798	877	156	655 721	486 251
1981	2 740 736	913	303	419 865	455 500
1982	3 086 000	805	59	291 193	356 000
1983	1 744 722	967	396	543 599	359 000
1984	2 766 805	1 045	236	1 132 892	482 000
1985r	3 182 900	889	499	1 279 764	447 000
1986r	3 346 100	706	963	1 292 623	438 000
1987	2 769 800	3 922	6 302	4 487 532	574 000
1988	3 367 200	See Table 2	See Table 2	3 294 323[3]	663 000p
1989	3 502 800	See Table 2	See Table 2	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada; U.S. Department of Commerce.
[1] From 1970 through 1984, the data represent producers' shipments of columbium ores and concentrates and primary products, Cb_2O_5 content. From 1985 onward, the data represent company published information.
[2] From U.S. Department of Commerce, Imports of Merchandise for Consumption, Report FT 135. Quantities in gross weight of material. [3] January to November 1988. [4] Available data as reported by consumers.
p Preliminary; r Revised; . . Not available.

TABLE 2. CANADA, COLUMBIUM (NIOBIUM) IMPORTS, 1988 AND 1989

Item No.		1988		Jan.-Sept. 1989p	
		(kilograms)	($000)	(kilograms)	($000)
Imports					
2615.90.00 10	Niobium ores and concentrates				
	Brazil	-	-	3 103	154
	United States	11 712	4	18 012	15
	Total	11 712	4	21 116	169
7202.93.00	Ferro-niobium				
	United States	382 981	2 572	475 174	4 609
	Brazil	796 120	6 188	438 837	4 056
	Total	1 179 101	8 761	914 012	8 665
8112.91.10 40	Niobium (columbium), unwrought metal, not alloyed; powders, not alloyed				
	United States	426	22	64	4
	Total	426	22	64	4
8112.91.20 14	Niobium (columbium), unwrought metal, not alloyed, powders, not alloyed				
	United States	147	7	227	15
	Total	147	7	227	15
8112.99.90 40	Niobium (columbium), other				
	United States	8 391	902	4 612	417
	Total	8 391	902	4 612	417

Source: Statistics Canada.
p Preliminary; - Nil.
Note: Numbers may not add to totals due to rounding.

Copper

1989

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Canadian copper producers enjoyed their second consecutive year of strong prices and profitability in 1989. Production at both the mining and refining stages declined, however, largely due to a lengthy mine strike in British Columbia and technical problems at some mines and smelters. Mine shipments (recoverable copper) are estimated at 706 000 t compared with 758 000 t in 1988, and refined production at 509 000 t compared with 529 000 t. Estimated value of mine shipments rose only marginally to $2.41 billion in 1989 from $2.39 billion, despite higher prices, because of the reduced output and the strength of the Canadian dollar against the U.S. dollar.

Indicative of tight markets, copper stocks on the London Metal Exchange (LME) and the New York Commodities Exchange (COMEX) remained at very low levels throughout 1989. Prices again were volatile, averaging US$1.29 on the LME compared with $1.18 in 1988, and $1.25 on COMEX compared with $1.15.

Mine production in Canada should rebound to about 800 000 t in 1990 while refined production should approximate 1988's record 529 000 t, barring strikes and significant price weakness in the second half.

The terms of reference for a proposed International Copper Study Group, modelled on the 30-year-old International Lead and Zinc Study Group, were negotiated in 1989 and prospective member countries have until mid-1990 to join. The Study Group would improve market information and provide a forum for consultations among member countries, but it would have no market stabilization provisions. The U.S.-based International Copper Research Association, financed by copper producers worldwide, expanded its mandate to include copper market promotion in addition to research into new uses, and changed its name to the International Copper Association Ltd.

CANADIAN DEVELOPMENTS

Only limited new copper mining capacity and no smelting or refining capacity came on-stream in 1989. There was a modest but encouraging shift to base-metal exploration. Future mine development potential consequently looks more promising than at any time in the past six to eight years.

Mining

Minnova Inc., indirectly controlled by Noranda Inc., commenced production at the Ansil copper-zinc mine in northwestern Quebec following rehabilitation of its Norbec mill, and also opened the Samatosum silver-zinc-copper mine in south-central British Columbia. Noranda Inc. re-opened the E-Zone underground copper mine at Mines Gaspé, Quebec, and the Heath Steele and adjacent Stratmat zinc-lead-copper properties in New Brunswick. The Gaspé and Heath Steele mines had been closed in 1987 (due to an underground fire) and 1983, respectively.

Production also resumed at the Shebandowan nickel-copper mine of Inco Limited near Thunder Bay, Ontario and the Mobrun mine of Audrey Resources Inc. (70%) and Minnova Inc. (30%) in Quebec. Mining had initially begun at Mobrun in 1987 using Minnova's Norbec mill but was suspended in 1988 pending completion of a new 1000 t/d mill and additional mine development. The shaft will be further deepened by late 1992 to access the recently discovered 1100 lens. It contains probable reserves of 10.4 Mt grading 0.76% copper, 5.43% zinc plus gold and silver.

In addition, Hudson Bay Mining and Smelting Co., Limited (HBMS) began production at the Callinan zinc-copper mine at Flin Flon near year-end. Copper production in concentrates should total over 75 000 t/y from the seven new or re-opened mines.

Major developments at existing copper mines in British Columbia included the opening of the Ajax pit by Afton Operating Corporation to replace depleted pits, the preparation of the Pollyanna pit at Gibraltar Mines Limited for 1990 production, and the relocation by Highland Valley Copper of the former Highmont mill to the Lornex mill site and the closure of the older Bethlehem mill. Highland Valley's milling capacity was increased from

120 500 to 131 000 t/d, affirming the operation's position as one of the world's largest copper mines. Mining was halted by a strike from July 6 to October 20. In 1988, Highland Valley had produced nearly 175 000 t of copper in concentrates.

Two other large British Columbia mines had their operating lives extended. Cassiar Mining Corporation, which purchased the Similkameen mine near Princeton from Newmont Mines Limited in 1988, introduced a five-year mining plan and began evaluation of a 10-year plan. Shareholders also approved a corporate reorganization whereby Cassiar will become a subsidiary of the newly-formed Princeton Mining Corporation. On northern Vancouver Island, BHP-Utah Mines Ltd. is spending $60 million to extend the pit rim at its large, open-pit copper-molybdenum mine, thereby lengthening mine life from 1992 to 1996, albeit at a reduced production rate after 1992. Bethlehem Resources Corporation and Goldnev Resources Inc. acquired the Goldstream mine near Revelstoke, British Columbia from Noranda and plans to resume production in 1990. Reserves are estimated at 1.86 Mt grading 4.81% copper plus zinc and gold, and the mill is rated at 1100 t/d. Brenda Mines Ltd. (owned 69% by Noranda) will close its copper-molybdenum mine near Peachland in 1990 due to the exhaustion of ore reserves.

Processing

No additional copper smelting or refining capacity currently is planned in Canada, but Noranda neared completion of a $160 million acid plant at its Horne smelter in Quebec in order to meet provincial regulations for a 50% reduction in SO_2 emissions by January 1, 1990. Noranda plans additional technological initiatives to allow for a further 20% reduction by 1995, at an estimated cost of $16 million. Hudson Bay Mining and Smelting (HBMS) is considering modernizing its 60-year-old copper and zinc smelters at Flin Flon, and has been negotiating for federal and provincial loans under the Acid Rain Abatement Program to help finance the $132 million project. Copper smelter modernization would include the installation of a Noranda continuous reactor, but no increase in capacity would occur. Noranda's Canadian Copper Refiners Limited announced a $46 million, five-year modernization program at its Montreal East copper refinery, but capacity will remain at 350 000 t/y.

In Ontario, Inco plans to spend nearly $500 million over five years to modernize its nickel-copper milling and smelting operations in the Sudbury area in order to meet Ontario's 1994 SO_2 emission regulations. This project will include new oxygen flash furnaces to smelt bulk nickel-copper concentrates. Inco also has major nickel-copper mine development projects under way at its Sudbury operations, including the Lower Coleman mine to open in 1990 and the McCreedy East mine to open in 1993. Unlike its Sudbury mines, Inco's Thompson, Manitoba operations produce relatively little copper.

Falconbridge Limited has major mine development projects under way at both its Sudbury-area nickel-copper operations and the Kidd Creek copper-zinc operations at Timmins. The company, which was purchased by Noranda and Trelleborg AB of Sweden in September 1989, has a major shaft-sinking and underground development program under way at the Lindsley property near Sudbury and plans to spend $100 million over the next eight years to maintain ore production rates at Timmins.

Exploration

Considerable concern has been expressed that, without significant new discoveries and new mine development in Canada, copper mine production will decline quickly in the mid-1990s. Maintenance of mine production at current levels beyond that period is not yet assured, but a number of promising properties are in various exploration stages, particularly in British Columbia and Quebec.

In northwestern Quebec, the Louvicourt Township property of Aur Resources Inc. and Louvem Mines Inc. is reported to contain resources of 32.7 Mt grading 3.11% copper plus zinc, silver and gold, with the full extent of mineralization not yet determined. Minority interests have been acquired in Aur by Cominco Ltd. and Teck Corporation, and in Louvem by Noranda. Underground exploration may be launched in 1990 and, while no production plans have been announced, Aur has indicated that a 6000 t/d underground operation is being considered. Thus, annual copper production in concentrates could approximate 60 000 t/y. Litigation between Aur and Louvem, however, could potentially delay exploration progress.

Also in Quebec, Breakwater Resources Ltd. is exploring the Estrades zinc-copper property in the Casa Berardi area and planned to complete a feasibility study by the end of 1989 with a view to starting up production by 1992. Geological reserves are reported to be over 2 Mt grading 9.9%

zinc, 1.02% copper plus gold and silver. In the Abitibi region, VSM Exploration Inc. (controlled by Placer Dome Inc.) and Serem Quebec Inc. (owned by Bureau de Recherches Geologiques et Minières (BRGM) of France) are exploring the promising Grevet zinc-copper property near Matagami. Horizons III and IV are reported to contain 5.6 Mt grading 8.65% zinc, 0.48% copper and 34.9 g/t silver in the proven and probable categories. A pre-feasibility study now under way will assess a possible underground exploration program that could start in 1990.

In Newfoundland, the polymetallic Duck Pond property owned by Noranda and BP Resources Canada Limited is reported to contain over 4 Mt grading 3.5% copper plus zinc, lead, silver and gold. Exploration is continuing, seeking to prove up a larger orebody before a feasibility study is launched.

Cameco - A Canadian Mining & Energy Corporation completed a pre-feasibility study on the Hanson Lake zinc-copper property in Saskatchewan (65 km west of Flin Flon) which it owns with Trimin Resources Inc. The major zone (No. 2 lens) is estimated to contain 9.8 Mt of geological reserves grading 0.95% copper, 5.76% zinc, plus lead, gold and silver, with two other zones having 1.3 Mt grading over 2.2% copper. Exploration is continuing and a $7.1 million development program is planned for 1990, subject to a positive feasibility study. A $90 million, 2700 t/d mine is being considered for start-up in 1992.

Several low-grade copper-gold porphyry properties are under active exploration in British Columbia. Imperial Metals Corporation and its partners have contracted for a feasibility study on the Mount Polley property near Williams Lake, for completion in March 1990. It is reported that the property contains 48 Mt grading 0.44% copper and 0.6 g/t gold and that the partners are considering a $135 million, 13 600 t/d open-pit mining operation yielding about 14 500 t/y of copper in concentrates plus an initial 3100 kg/y of gold, dropping to 2330 kg/y beyond the first five years.

The Mount Milligan property near Mackenzie is reported to contain more than 272 Mt in two deposits, averaging about 0.3% copper and 0.9 g/t gold. The property is owned by Continental Gold Corp. (69.8%) and BP Resources (30.2%). Continental, the project operator, is continuing exploration on the property, and is studying the feasibility of a 50 000 t/d mine to produce about 45 000 t/y copper and up to 12 400 kg of gold. It was earlier reported that capital costs could be in the order of $300 million. Continental Gold and BP Resources are in a legal dispute relating to a corporate reorganization of the former.

In the extreme northwest corner of British Columbia, Geddes Resources Limited (owned 46% by Northgate Exploration Limited and 17% by Cominco Ltd.) continued exploration on the large Windy-Craggy property, reported to contain 120 Mt of probable reserves grading 1.67% copper plus gold, and 33 Mt of possible reserves of slightly lower grade. A pre-feasibility study is to be submitted to provincial authorities early in 1990. Capital costs could total about $400 million for an open-pit mining and milling operation to produce 120 000 t/y of copper in concentrates. The earliest that production could commence is 1994.

Other western Canadian properties recently under exploration include the more remote Kerr property in the Sulphurets area, reported to contain 66 Mt grading 0.86% copper plus gold and silver (recently acquired by Placer Dome Inc. through its takeover of Sulphurets Gold Corporation), and the formerly producing Wellgreen low-grade copper-nickel property in the Yukon. Reserves at the Kerr property are reported to exceed 60 Mt grading 0.86% copper and 0.34 g/t gold. A pre-feasibility study completed in 1989 for All-North Resources Ltd. estimated probable reserves at Wellgreen of 42.3 Mt grading 0.35% copper, 0.36% nickel plus minor platinum group metals, gold and cobalt. The study was based on a 10 000 t/d mine-mill operation plus an on-site smelter to produce nickel-copper matte. At this rate, copper production would be about 10 000 t/y in matte, but no plans have been announced for development, and exploration is continuing.

Further details on developments at Canadian copper mines are in the table, Principal Canadian Nonferrous and Precious Metal Mine Production in 1988, with Highlights for 1989.

WORLD DEVELOPMENTS

Western world copper production rose by an estimated 3.6% at the mining stage in 1989 and by an estimated 3.3% at the refined stage, to 6.9 Mt and 8.3 Mt, respectively.

As in Canada, rising copper consumption and prices have prompted renewed interest worldwide in the development of new mining and processing projects. In fact, the amount of new capacity potentially coming on-stream between 1989 and 1993 has begun to worry copper market analysts out of concern that the industry is collectively overreacting to recent supply shortfalls.

Only the most significant developments can be noted here but, as in Canada, many of the prospective new copper mines worldwide contain gold that helps to justify their development. This is true of many properties in Australia, the Philippines and elsewhere in Asia. For example, Freeport Indonesia Inc., a subsidiary of Freeport-McMoRan Inc., is expanding mining and milling capacity in Indonesia from 20 000 t/d to 32 000 t/d by mid-1990 and to 52 000 t/d by mid-1992, with further development of the recently discovered Grasberg deposit near the existing Ertsberg mine. Grasberg is reported to contain 118 Mt of proven and probable reserves grading 1.52% copper, 1.58 g/t gold and minor silver with the deposit not yet fully defined. The Indonesian government has asked Freeport to study the feasibility of a new smelter in connection with renewal of its mining lease in 2003.

Another major factor has been rapid growth in copper production by the Solvent Extraction-Electrowinning (SX-EW) process. It involves leaching of oxide ores and the recovery of refined cathode from the leach solutions at operating costs typically below US30¢/lb. Most SX-EW capacity is going into the United States, Chile and Africa, which have substantial reserves of oxide copper. Total SX-EW capacity was approximately 700 000 t/y at the end of 1989. Unfortunately, this highly competitive technology is not generally suited to Canadian ores for climatic and mineralogical reasons. Copper ores in Canada are mostly sulphides which contain by-products, and the SX-EW process does not recover the precious metals which typically are important for production viability in Canada. The only SX-EW plant in Canada is the 4500 t/y unit at Gibraltar Mines Limited in British Columbia.

Chile and the United States lead the world in mining expansions. In Chile, government-owned Corporacion Nacional del Cobre de Chile (Codelco-Chile) will spend US$1.35 billion over five years to expand its Chuquicamata, El Teniente and El Salvador operations. The company's copper production is projected to rise from 1.243 Mt in 1989 to 1.32 Mt in 1993 but then revert to about 1.2 Mt/y thereafter, due to declining ore grades.

The private sector is undertaking major investment projects in Chile. Total Chilean copper production is projected to rise from about 1.5 Mt in 1989 to over 2 Mt/y by 1992 or 1993. Major projects include the US$1.1 billion Escondida complex, due on-stream in April 1991 at 320 000 t/y copper in concentrates, and expansion of Exxon Corporation's Disputada de las Condes Mining Co. Inc. operations from 46 000 t/y copper to 130 000 t/y by early 1992. Several other expansions and new mines are also planned, including the Quebrada Blanca deposit where Cominco Ltd., Cominco Resources International Limited and two Chilean partners are planning a 40 000 t/y SX-EW operation that could start production in 1993 (Cominco Resources and its local partner also plan to start production at the Maria property in Mexico in 1990 at about 10 000 t/y copper in concentrates).

All five of the major U.S. copper producers, Phelps Dodge Corporation, Magma Copper Company, Cyprus Minerals Company, ASARCO Incorporated and Kennecott Corporation (now a subsidiary of RTZ Corporation PLC), have expansions on their books, using both conventional milling-pyrometallurgy and SX-EW technologies. Their total copper capacity in all forms is currently some 1.4 Mt/y, or about 90% of the U.S. total. SX-EW capacity has risen from about 100 000 t/y in 1984 to nearly 400 000 t at the end of 1989, and potentially could exceed 600 000 t by 1994. To date, about two thirds of SX-EW capacity is based on low-grade dumps but most future capacity will be based on newly mined ore.

In Portugal, the Neves Corvo mine began commercial production early in 1989 at a rate of 115 000 t/y but will be expanded by at least 20 000 t/y in 1991 when a tin recovery plant is completed. Significant new copper mining capacity is also under construction or is planned in Australia, the Philippines, Mexico, India, Brazil, Burma and elsewhere.

Plans to expand capacity for copper smelting and refining (other than SX-EW) are much more limited than for mining. Among the few new plants are a 182 000-200 000 t/y smelter in Texas planned by a consortium led by Mitsubishi Metal Corporation for 1991 completion, and the 100 000 t/y Luilu electrolytic refinery in Zaire to start up in 1991 and reach full capacity in 1993. Mitsubishi is also replacing its existing reverberatory smelter with a Mitsubishi continuous smelter rated at 204 000 t/y. CRA Limited is replacing or modernizing most components of its Port Kembla refinery in Australia and doubling capacity through the installation of a Noranda continuous reactor to replace the existing reverberatory furnace. Other smelter and refinery expansions include the Teniente smelter of Codelco-Chile and Empresa Nacional de Mineria (ENAMI) in Chile, Philippines Associate Smelting and Refining Corp. (PASAR), and two small plants in India. New smelters, refineries or expansions are being studied in Portugal, Chile, Brazil, Oman, Morocco, Thailand and Indonesia, but few of these should be regarded as serious projects at this time.

CONSUMPTION AND USES

Canadian refined copper consumption in 1989 is estimated to have risen by 4-5% from the 238 521 t in 1988 to approximately 250 000 t. Western world refined consumption rose by 3-4% from the 8.3 Mt in 1988, to an estimated 8.6 Mt. The World Bureau of Metal Statistics reported production of refined copper from secondary materials of 1.33 Mt in 1988 (which is included in refined consumption) and the direct use of scrap by manufacturers (which is not included) of 4.33 Mt. Thus, over 40% of overall copper use in the western world is derived from recycled materials.

Copper's high electrical and thermal conductivity combined with its tensile strength, elevated melting point (1083°C), non-magnetic properties and resistance to corrosion make it very attractive for electrical transmission, water tubing, castings and heat exchangers. It is the most efficient conductor of electrical power, signals and heat of all of the industrial metals (aluminum's electrical and thermal conductivity is only 72% and 76%, respectively, of that of copper). Approximately 60% of copper consumption in the western world is used in the fabrication of wire.

In Canada, detailed copper consumption statistics are not collected officially. The Canadian Copper and Brass Development Association (CCBDA), an association of producers and fabricators, collects certain statistics for its members. The CCBDA disseminates information to copper users and provides technical assistance to encourage and foster copper consumption in Canada. Besides the traditional uses, copper is consumed in Canada for retrofitting of fire suppression systems, natural gas tubing in residences, central vacuuming and roofing. Changes are being contemplated that would require fire suppression systems in all new residential dwellings; copper is the preferred material for such systems.

The United States has the best publicly available copper consumption data. Table 8 presents preliminary end use data for 1988 collected by the U.S. Copper Development Association Inc. (US CDA). These clearly indicate the importance of building construction to copper consumption, with 41% of use. The average, new U.S. house contains about 100 kg of copper wire. Usage is rising as houses grow in size and incorporate more labour-saving and other electrical devices. In a study completed in the early 1980s, the US CDA determined that about 165 kg of copper in all forms were required to build an average 150 m^2 (1700 $ft.^2$) house. A 90 m^2 (1000 $ft.^2$) multiple dwelling consumed 113 kg. Renovations also increase copper consumption when kitchen and plumbing facilities are brought up to modern standards.

Electrical and electronic products accounted for 22% of U.S. copper usage, followed by industrial machinery and equipment with 14%, transportation equipment with 12% and consumer and other products with 10%. While copper use in automotive radiators has declined due to the market penetration of aluminum radiators, the increased use of copper in electrical circuits has more than offset declining non-electrical copper consumption in vehicles. The typical vehicle in the United States had 450 electrical circuits in 1975 and about 900 circuits in 1988, and this is expected to rise to about 1200 circuits in 1992. The average U.S. vehicle contained about 22 kg of copper and copper alloys in 1986, up from 16 kg in 1980. Automotive demand for copper is expected to continue to increase through the 1990s.

The telecommunications market for copper has declined in the United States, principally due to technological advances. While the effect of fibre optics is widely publicized, fibres have only recently started to compete with copper in the subscriber loop, where 80% of the copper in the telephone system is used. Also, multiplexing and reduction of gauge have reduced the amount of copper used per telephone circuit. Therefore, telecommunications will diminish even more quickly as a market for copper in the 1990s than in the 1970s and 1980s.

Some of the fibre-optics applications are in markets that copper has already lost. Satellites and microwave stations handle much of the long-haul telecommunications. In December 1988, the first trans-Atlantic fibre-optics cable, TAT-8, went into service and is capable of handling 40 000 simultaneous conversations. (TAT-7, a copper cable with an 8500 conversation capacity, installed in 1983, will remain in service.) A trans-Pacific fibre-optics cable was completed in 1989.

There have been advances in super-conductivity at higher temperatures, but practical, high-current super-conductors for industrial loads have yet to be developed. Long-haul super-conductors should first compete with overhead high-tension wires, presently made of aluminum. If super-conductors make electrical power more accessible and cheaper, the increased use of electrical equipment should increase overall demand for copper.

Substitutes for copper include aluminum in electrical and thermal transfer applications, plastics in tubing applications and fibre optics for telecommunications. Since the mid-1970s, copper has regained some of the insulated conductor market previously lost to aluminum. But electrically conductive plastics are now being investigated, for example, in household appliances.

Table 7 shows western world copper consumption by country in 1988 with estimates for 1989; the United States ranks first. The developed countries (Western Europe, the United States, Japan, Canada, Australia and New Zealand) together consumed 82% of the western world's copper at the semi-manufacturing stage in 1988, down from 93% in 1973 and 87% in 1980, as other countries have developed local manufacturing industries and developed countries' economies have matured. Growth in the so-called newly industrializing countries such as South Korea, Taiwan, Brazil, Mexico and Southeast Asia has been particularly high.

In the past, copper-deficient industrialized countries have often adopted policies to encourage development of diverse supplies of raw materials via aid and assistance with financing. Such policies have been reinforced by tariffs, with no or low tariffs on raw materials but progressively higher tariffs on processed, semi-manufactured and manufactured goods.

TRADE

About 1.5 Mt of copper in concentrates is traded yearly in the western world. Canada is the largest exporter (378 000 t in 1988) followed by Chile (225 000 t), Papua New Guinea (220 000 t) and the United States (197 000 t). Blister and anode copper trade is about half that of concentrate, averaging about 700 000 t/y. Refined trade totals about 3 Mt/y. In all, the yearly trade of the three forms of copper totals 4.9 Mt/y-5.3 Mt/y (with some double counting). East-west trade is relatively small, with exports from western countries representing 2.8% of total copper trade in 1988 and imports into western countries representing 5.7% of trade.

HEALTH AND THE ENVIRONMENT

Human and animal health depends on an adequate dietary intake of copper (as it does on many other trace metals). Copper combines with proteins to form many enzymes critical for life. One such important enzyme is superoxide dismutase which removes the superoxide radicals in the human body. Superoxide radicals are the "residues" of metabolic processes which otherwise could build to toxic levels. Copper is also required to transport iron from absorption sites to the bone marrow where red blood cells are produced.

Many regulatory agencies have chosen 1 part per million (ppm) as the maximum desirable concentration of copper in drinking water. It signifies more an aesthetic than a health limit: water containing more than 1 ppm can stain laundry, and persons with a keen sense of taste may perceive a metallic flavour in the water.

Copper tubing used for distribution of potable water supplies has beneficial bactericidal characteristics. It has been noted, for example, that the **Legionnella pneumonillia** bacteria causing Legionnaire's disease and Pontiac fever were present in many hotel systems, but not in those with copper water systems.

Like most metals, copper is found in small concentrations in nature. The mining of copper generates significant amounts of solid wastes in tailings ponds and, to a lesser extent, in rock dumps. Due to associated minerals such as pyrites in the ore, the wastes generate acid when exposed to oxygen in the air. Commonly, mine operators control acid generation by keeping the tailings areas below the water table and covering acid-generating waste with soil.

Most of the environmental concerns that arise from producing copper are associated with the sulphur dioxide emissions that result from copper smelting. In Canada, Noranda closed the reverberatory furnace at its Horne smelter in early 1989 and completed construction of a 350 000 t/y acid plant at year-end. Noranda thus has the option of re-opening the reverberatory furnace, depending upon feed availability and treatment and refining charges. In Ontario, Inco will spend $69 million to rationalize milling operations and to reduce some sulphur input to the smelting process by selective rejection of iron sulphide. Inco will spend a further $425 million to reduce sulphur emissions from its Sudbury copper and nickel smelters. Falconbridge will spend $38 million to reduce emissions at its smelter in Sudbury.

Finally, HBMS plans to modernize its zinc and copper smelters in Manitoba but, while SO_2 emissions will be reduced in zinc processing in order to meet provincial emission limits, they will not initially be captured at the copper smelter due to the lack of economically viable technology to do so at this time.

MARKETS, STOCKS, PRICES AND OUTLOOK

Global copper markets remained strong throughout 1989 despite a broad but erroneous consensus at the end of 1988 that demand would soon begin to weaken. Similarly, supply grew much slower than had been projected due to production disruptions. With western world mine production estimated at 6.9 Mt and refined production at 8.3 Mt, and consumption estimated at 8.6 Mt, total inventories were drawn down further during the year.

Copper supplies were reduced with the closure of the large Bougainville mine in Papua New Guinea due to terrorist actions, Highland Valley Copper in British Columbia due to a three-and-a-half-month strike, the Cia Minera de Cananea SA mining and processing operation in Mexico for two months due to a declaration of bankruptcy, and several operations in Peru due to strikes. Output was also below target in Zambia, Zaire and Chile. Technical problems reduced copper production at smelters in Chile, Finland, the United States and Canada. Combined stocks on the LME and COMEX remained at very low levels through 1989, opening at 79 763 t, rising to 154 189 t in May and then fluctuating between 85 000 t and 126 000 t for the remainder of the year. Closing stocks totalled 115 278 t.

The LME and COMEX predominate in establishing copper prices worldwide. Both exchanges trade in spot or "cash" metal as well as in futures contracts. Figure 2 shows daily LME cash prices from 1987 to 1989 in US$/lb. while Figure 3 shows monthly average LME prices from 1965 to 1989. Following a renewed price surge late in 1988, the LME Grade A cash copper price, which began 1989 at $1.61 (which proved to be the annual daily high), declined to $1.10 in July, rallied to $1.41 in August in response to production disruptions, and then trended downward to end the year at $1.11. As noted in the introduction, prices on average exceeded those in 1988, with the LME averaging US$1.29/lb. and COMEX averaging $1.25. Canadian producers sell refined copper in the United States at COMEX plus premia of US4.75-5.5¢/lb., in Canada at the Canadian dollar equivalent of COMEX plus 3.5-6.5¢/lb., and in Europe at LME plus £7-25/t, depending on pricing criteria selected by the buyer.

The outlook for 1990 is somewhat less favourable, especially for the second half. With signs of the long-anticipated recession beginning to appear in North America, western world copper consumption is expected to remain relatively flat. Nevertheless, substantial new capacity on-stream in 1989 and 1990 suggests an emerging copper surplus in 1990. Even though inventories need to be replenished, any signals of oversupply - barring a continuation of 1989's production disruptions - will dampen market psychology and, therefore, the prices. Consequently, LME prices are expected to continue their downward trend through 1990, remaining reasonably strong in the first half but possibly dropping below US80¢ by year end, and to average under $1.00 over the year.

In the longer term, mine expansion threatens to push the market into a clear surplus between 1991 and about 1993. The Department of Energy, Mines and Resources is currently projecting annual average prices to trend slowly downward through the 1990s but within a relatively wide range of US65-90¢/lb. in 1991 to 55-85¢/lb. by 2000.

Note: Information contained in this review was current as of mid-January 1990.

TARIFFS

		Canada			United States	EEC	Japan[1]
Item No.	Description	MFN	GPT	USA	Canada	MFN	MFN
2603.00	Copper ores and concentrates						
2603.00.00.10	-----Copper content	Free	Free	Free	Free	Free	Free
2825.50	-Copper oxides and hydroxides	Free	Free	Free	3.1 to 4.0%	3.2%	7.2%
28.33	Sulphates; alums; peroxosulphates						
	-Sodium sulphates:						
2833.25	--Of copper						
2833.25.10	---Cupric sulphate	6.8%	Free	4.0%	1.1%	3.2%	5.8%
74.01	Copper mattes; cement copper (precipitated copper)						
7401.10	-Copper mattes	Free	Free	Free	0.5¢/kg on copper content	Free	Free
74.03	Refined copper and copper alloys, unwrought						
	-Refined copper						
7403.11	--Cathodes and sections of cathodes	Free	Free	Free	0.8%	Free	21 yen/kg
7403.12	--Wire-bars	4.0%	Free	2.4%	0.8%	Free	21 yen/kg
7403.13.00	--Billets	Free	Free	Free	0.8%	Free	21 yen/kg
7403.19	--Other						
7403.19.10	---Ingots, ingot-bars and slabs	Free	Free	Free	0.8%	Free	21 yen/kg
7403.21	--Copper-zinc base alloys (brass)						
7403.21.10	---Ingots, ingot-bars, slabs and billets	4.0%	Free	2.4%	0.8%	Free	21 yen/kg
7403.22	--Copper-tin base alloys (bronze)	10.3%	6.5%	6.1%	0.8%	Free	21 yen/kg
7404.00	Copper waste and scrap						
7404.00.10	---Not alloyed	Free	Free	Free	Free	Free	Free
	---Alloyed						
7404.00.21	----Copper-zinc base alloys (brass)	4.0%	Free	2.4%	Free	Free	Free
7405.00	Master alloys of copper	10.3%	6.5%	6.1%	2% to 4.8%	Free	6.0%
74.06							
7406.10	-Powders of non-lamellar structure						

7406.10.10	---Not alloyed	4.0%	Free	3.2%	4.8%	1.4%	7.2%
7406.20	-Powders of lamellar structure; flakes						
7406.20.10	---Not alloyed	4.0%	Free	3.6%	2.7%	6.2%	7.2%
74.07	Copper bars, rods and profiles						
7407.10	-Of refined copper						
	---Unworked						
7407.10.11	----Bars and rods, of a maximum cross-sectional dimension not exceeding 12.7 mm	4.5%	3.0%	3.6%	0.9% to 5.6%	6.0%	7.2%
	-Of copper alloys						
7407.21	--Of copper-zinc base alloys (brass)						
	---Unworked						
7407.21.11	----Bars and rods, of a maximum cross-sectional dimension not exceeding 12.7 mm	4.5%	3%	3.6%	1.7% to 2.8%	6.0%	7.2%
7407.21.12	----Bars and rods, of a maximum cross-sectional dimension exceeding 12.7 mm; profiles	4%	Free	3.2%	1.7% to 2.8%	6.0%	7.2%
74.08	Copper wire						
	-Of refined copper:						
7408.11	--Of which the maximum cross-sectional dimension exceeds 6 mm						
	---Not exceeding 12.7 mm:						
7408.11.11	----Not coated or covered	4.5%	3.0%	4.0%	0.9% to 3.6%	6.0%	7.2%
	---Exceeding 12.7 mm						
7408.11.21	----Not coated or covered	4.0%	Free	3.2%	0.9% to 3.6%	6.0%	7.2%
74.09	Copper plates, sheets and strip, of a thickness exceeding 0.15 mm						
	-Of refined copper						
7409.11	--In coils						
7409.11.10	---Unworked	4.0%	Free	3.2%	6.0%	6.0%	6.5%
7409.19	--Other						
7409.19.10	---Unworked	4.0%	Free	3.2%	4.2%	6.0%	6.5%

TARIFFS (cont'd)

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
	-Of copper-zinc base alloys (brass):						
7409.21	--In coils						
7409.21.10	---Unworked	4.0%	Free	3.2%	1.7%	6.0%	6.0%
7409.29	-Other						
7409.29.10	---Unworked	4.0%	Free	3.2%	1.7%	6.0%	6.0%
74.10	Copper foil (whether or not printed or backed with paper, paperboard, plastics or similar backing materials) of a thickness (excluding any backing) not exceeding 0.15 mm						
	-Not backed:						
7410.11	--Of refined copper						
7410.11.10	---Unworked	4.0%	Free	3.2%	0.9%	6.5%	6.0%
74.11	Copper tubes and pipes						
7411.10	-Of refined copper						
7411.10.10	---Unworked	4.0%	Free	3.2%	1.3%	6.0%	6.5%
	-Of copper alloys:						
7411.21	--Of copper-zinc base alloys (brass)						
7411.21.10	---Unworked	4.0%	Free	3.2%	1.2%	6.0%	6.5%
74.12	Copper tube or pipe fittings (for example, couplings, elbows, sleeves)						
7412.10	-Of refined copper	10.3%	6.5%	8.2%	10.0%	6.5%	5.8%
7412.20	-Of copper alloys	10.3%	6.5%	8.2%	2.8%	6.5%	5.8%
7413.00	Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	10.3%	6.5%	8.2%	3.6% to 5.1%	Free to 6.5%	7.2%

74.15	Nails, tacks, drawing pins, staples (other than those of heading No. 83.05) and similar articles, of copper or of iron or steel with heads of copper; screws, bolts, nuts, screw hooks, rivets, cotters, cotter-pins, washers (including spring washers) and similar articles, of copper						
7415.10	-Nails and tacks, drawing pins, staples and similar articles	10.3%	6.5%	8.2%	4.5%	6.5%	5.8%
	-Other threaded articles:						
7415.31	--Screws for wood	10.2%	6.5%	8.1%	4.9%	4.9%	5.8%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Custom Tariff Schedules of Japan, 1989.

[1] GATT rate is shown, lower tariff rates may apply circumstantially.

TABLE 1. CANADA, COPPER PRODUCTION AND TRADE, 1988 AND 1989

	1988		1989p	
	(tonnes)	($000)	(tonnes)	($000)
Shipments[1]				
Nova Scotia	x	x	x	x
New Brunswick	7 966	25 139	8 264	28 259
Quebec	47 633	150 319	60 209	205 915
Ontario	286 536	904 235	261 121	892 892
Manitoba	53 072	167 483	49 763	170 163
Saskatchewan	2 168	6 842	625	2 137
British Columbia	360 570	1 137 869	325 756	1 113 911
Yukon	x	x	x	x
Northwest Territories	x	x	1	3
Total	758 478	2 393 568	706 117	2 414 572
Refinery output	528 723	. .	509 000	. .
			(Jan.-Sept.)	
Exports				
Copper ores and concentrates				
-----Copper content				
Japan	249 093	550 513	200 077	542 437
Spain	19 290	48 495	27 911	77 047
South Korea	4 556	12 974	24 698	69 250
Philippines	165	340	14 627	37 266
People's Republic of China	11 702	27 391	10 726	27 394
Other countries	46 034	111 650	17 575	51 657
Total	330 840	751 363	295 614	805 051
Other ores and concentrates				
United States	168	39	15	58
Belgium	–	–	30	50
Norway	2 315	3 875	–	–
Japan	4 147	1 624	–	–
Total	6 630	5 538	45	108
-Copper oxides and hydroxides				
United States	20	30	–	–
Other countries	–	1	–	–
Total	20	31	–	–
Copper mattes: cement copper (precipitated copper)				
-Copper mattes				
Norway	9 954	19 192	10 766	27 179
Other countries	979	2 232	1 739	4 148
Total	10 933	21 424	12 505	31 327

TABLE 1. (cont'd)

	1988		Jan. - Sept. 1989p	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Refined copper and copper alloys, unwrought				
-Refined copper:				
United States	185 564	573 045	131 584	449 012
United Kingdom	34 162	104 667	56 964	196 106
Netherlands	2 661	8 196	23 557	78 240
West Germany	10 318	30 135	10 108	34 614
Italy	5 836	18 330	8 381	29 129
Sweden	13 678	37 551	8 283	28 761
France	6 554	21 311	5 010	18 150
Japan	625	1 837	868	2 964
South Korea	-	-	755	2 858
Other countries	2 444	7 291	511	2 003
Total	261 842	802 363	246 021	841 837
-Other copper alloys:				
United States	5 571	15 568	1 823	7 576
Other countries	201	464	927	2 118
Total	5 772	16 032	2 750	9 694
Copper waste and scrap				
United States	57 152	121 253	35 393	86 499
South Korea	4 390	9 689	2 995	7 596
West Germany	4 030	7 128	2 877	5 557
United Kingdom	2 457	4 889	1 718	3 845
India	2 021	2 522	2 164	3 481
Other countries	5 903	10 928	4 821	9 705
Total	75 953	156 409	49 968	116 683
Master alloys of copper				
United States	62	232	61	247
United Kingdom	59	171	-	-
Total	121	403	61	247
Copper powders and flakes				
United States	213	1 088	272	1 450
Other countries	102	711	76	651
Total	315	1 799	348	2 101
Copper and copper alloy rods and profiles				
United States	12 301	38 594	6 824	30 208
Other countries	1 748	5 805	465	2 241
Total	14 049	44 399	7 289	32 449
Copper and copper alloy wire				
United States	1 498	5 820	1 617	2 806
Other countries	2 051	6 552	1 700	5 383
Total	3 549	12 372	3 317	8 189

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989p	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Copper and copper alloy plates, sheets strip and foil				
United States	17 212	62 204	12 012	44 415
Other countries	2 309	7 748	786	2 670
Total	19 521	69 952	12 798	47 085
Copper and copper alloy tubes and pipes				
United States	6 569	35 000	3 955	22 179
Other countries	943	3 989	712	3 548
Total	7 512	38 989	4 667	25 727
Copper and copper alloy tube and pipe fittings				
United States	. .	9 100	. .	5 835
Other countries	. .	6 446	. .	2 494
Total	. .	15 546	. .	8 329
Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated				
United States	147	411	28	114
Other countries	290	1 242	40	170
Total	437	1 653	68	284
Cloth, fastener and other items of copper				
United States	. .	11 722	. .	9 244
Other countries	. .	1 602	. .	5 458
Total	. .	13 324	. .	14 702
Imports				
Copper ores and concentrates				
-----Copper content	41 464	81 869	15 253	50 507
Other ores and concentrates	13 541	9 219	1 675	3 293
-Copper oxides and hydroxides	883	2 497	607	1 885
Sulphates; alums; peroxosulphates (persulphates)				
-Sodium sulphates				
--Of copper	3 897	3 204	4 721	3 671
Copper mattes; cement copper (precipitated copper)				
-Copper mattes	190	135	78	-
Refined copper and copper alloys, unwrought				
-Refined copper	6 895	11 942	2 665	7 988
-Other copper alloys	1 940	7 786	1 303	6 101
Copper waste and scrap	91 107	142 454	74 364	132 949
Master alloys of copper	13	70	55	207
Copper powders and flakes	1 126	4 886	871	4 178
Copper and copper alloy rods and profiles	35 818	105 386	17 077	56 689

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989p	
	(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)				
Copper and copper alloy wire	146 135	76 726	19 273	77 981
Copper and copper alloy plates, sheets, strip and foil	15 603	58 389	9 627	45 214
Copper and copper alloy tubes and pipes	9 905	49 836	9 160	49 994
Copper and copper alloy tube and pipe fittings	5 163	35 560	3 542	27 007
Stranded wire, cables, plaited bands and the like, of copper, not electrically insulated	2 326	9 602	2 877	13 029
Cloth, fastener and other items of copper	1 514	49 925	922	36 382

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Anode copper recovered in Canada from domestic concentrates plus exports of payable copper in concentrates and matte.

p Preliminary; . . Not available or not applicable; x Confidential; – Nil.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, COPPER PRODUCTION, TRADE[1] AND CONSUMPTION, 1970, 1975, 1980 AND 1984-89

	Production		Exports				
	Shipments[2]	Refinery Output	Concentrates and Matte	Refined	Total	Imports Refined	Consumption[3] Refined
				(tonnes)			
1970	610 279	493 261	161 377	265 264	426 641	13 192	229 026
1975	733 826	529 197	314 518	320 705	635 223	10 908	196 106
1980	716 363	505 238	286 076	335 022	621 098	13 466	208 590
1984	721 826	504 262	332 373	345 985	678 358	25 563	231 039
1985	738 637	499 626	320 619	280 033	600 652	19 131	222 466r
1986	698 527	493 445	341 390	306 822	648 212	20 901	225 586r
1987	794 149	491 124r	381 126	288 800	669 926	16 583	231 288r
1988	758 478	528 723	348 404	261 842	610 246	6 895	238 515
1989p	706 117	509 000	308 164[4]	246 021[4]	554 185[4]	2 665[4]	215 642

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. [2] Anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and matte. [3] Producers' domestic shipments of refined copper plus imports of refined shapes. [4] January to September 1989.

p Preliminary; r Revised.

TABLE 3. WESTERN WORLD PRODUCTION OF RECOVERABLE COPPER IN CONCENTRATES, 1988 AND 1989

	1988	1989●
	(000 t)	
Chile	1 451.0	1 530
United States	1 419.8	1 520
Canada[1]	758.5	706
Zaire	465.1	470
Zambia[2]	476.2	440
Peru	298.3	300
Australia	238.3	300
Mexico	273.5	255
Philippines	218.3	200
Papua New Guinea	213.7	170
Other	849.2	1 009
Total	6 661.9	6 900

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

[1] Data are for shipments. [2] Includes SX-EW material from reprocessing of tailings.

● Estimated from six months' data and other information.

TABLE 4. WESTERN WORLD PRODUCTION OF REFINED COPPER[1], 1988 AND 1989

	1988	1989●
	(000 t)	
United States	1 859.3	1 950
Chile	1 012.7	1 080
Japan	955.1	990
Canada	528.7	509
Federal Republic of Germany	426.4	466
Zambia[2]	447.9	465
Belgium	434.2	440
Australia	222.7	250
Zaire	202.8	200
Brazil	185.9	190
Peru	179.5	180
Other	1 477.4	1 580
Total	8 032.6	8 300

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

[1] Includes primary, secondary and electrowon copper. [2] Includes some material from Zaire.

● Estimated from six months' data and other sources.

TABLE 5. WESTERN WORLD CONSUMPTION OF REFINED COPPER, 1988 AND 1989

	1988	1989e
	(000 t)	
United States	2 269	2 300
Japan	1 331	1 430
Federal Republic of Germany	796	820
Italy	445	450
France	409	440
Belgium	318	370
United Kingdom	328	335
South Korea	266	270
Canada	239	250
Taiwan	215	240
Brazil	232	232
Other		
Total	8 304	8 600

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

e Estimates based on partial year's data and other information.

TABLE 6. COPPER AND COPPER-NICKEL SMELTERS IN CANADA, 1989

Company and Location	Product	Rated Annual Capacity	Blister or Anode Copper Produced in 1989 (1988)	Remarks
		(tonnes of concentrates)	(tonnes)	
Falconbridge Limited Falconbridge, Ontario	Copper nickel matte	570 000	25 200 (28 100)	Fluid bed roasters and electric furnaces; 1800 t/d sulphuric acid plant treats roaster gases. Matte from the smelter is refined in Norway.
Inco Limited Sudbury, Ontario	Molten "blister" copper, nickel sulphide and nickel sinter for the company's refineries; nickel oxide sinter for market, soluble nickel oxide for markets	1 500 000	122 368[1] (117 059)	Oxygen flash-smelting of copper concentrate; converters for production of blister copper. Roasters, reverberatory furnaces for smelting of nickel-copper concentrate, converters for production of nickel-copper Bessemer matte. Production of matte followed by matte treatment, flotation, separation of copper and nickel sulphides, then by sintering to make sintered nickel products for refining and marketing. Electric furnace melting of copper sulphide and conversion to blister copper.
Falconbridge Limited, Timmins, Ontario	Molten "blister" copper	400 000	105 676 (103 980)	Mitsubishi-type smelting, separation and converting furnaces, acid plant and oxygen plant to treat continuous copper concentrate feed stream to yield molten 99% pure copper which is transported by ladles and overhead cranes to two 350 t anode furnaces.
Noranda Inc., Horne smelter Noranda, Quebec	Copper anodes	838 000	143 000 (180 000)	One oxy-fuel fixed reverberatory furnace (currently closed), one continuous Noranda process reactor and five converters; oxygen for the reverberatory furnace and Noranda reactor is supplied by two plants with a combined total of 540 t/d. Continuous reactor modified to produce matte instead of metal. Acid plant built and operational by end 1989. Noranda may restart reverberatory furnace in 1990.
Noranda Inc., Gaspe smelter Murdochville, Quebec	Copper anodes	215 000	66 000 (66 000)	Green charge reverberatory furnace, two converters, rotary anode furnace and an acid plant. Treats Gaspe and custom concentrates.
Hudson Bay Mining and Smelting Co., Limited (HBMS) Flin Flon, Manitoba	Copper anodes	400 000	63 800 (57 700)	Five roasting furnaces, one reverberatory furnace and three converters. Company treats its own copper concentrate from mines at Flin Flon, Leaf Rapids and Snow Lake, as well as custom copper concentrates; zinc plant residues and stockpiled zinc-plant residues fed to reverberatory furnace.

Source: Data provided by each company.

[1] Production of anode not available, figures cited are for refinery output which includes a small tonnage of copper from Inco's Manitoba operations.

TABLE 7. COPPER REFINERIES IN CANADA, 1989

Company and Location	Rated Annual Capacity	Output in 1989 (1988)	Remarks
	(tonnes)		
Noranda Inc., Division CCR East Montreal, Quebec	370 000	315 836 (343 443)	Refines anodes from Noranda's Horne and Gaspé smelters, from the Flin Flon smelter and also from purchased scrap. Copper sulphate and nickel sulphate recovered by vacuum evaporation. Precious metals, selenium and tellurium recovered from slimes. Produces CCR brand electrolytic copper cathodes, cakes and billets. Tankhouse modernization program under way.
Inco Limited Copper Cliff, Ontario	180 000	122 368 (117 059)	Casts and refines anodes from molten converter copper from the Copper Cliff smelter; also refines purchased scrap. Gold, silver, selenium and tellurium cake recovered from anode slimes, which are further processed at Port Colborne to recover platinum metals concentrates. Recovers and electrowins copper from Copper Cliff nickel refinery residue. Produces ORC brand electrolytic copper cathodes. Modernization completed in 1988.
Falconbridge Limited Timmins, Ontario	92 000	94 992 (90 735)	Molten copper from two 350 t anode furnaces is cast in a Hazelett continuous casting machine into continuous copper strip, then formed to 145 kg anodes in a blanking press. Spent and scrap anodes are remelted in a 40 t ASARCO shaft furnace. Cathodes formed in jumbo-sized electrolytic tanks in a highly automated tank-house. A decopperized precious metal slime is also marketed.

Source: All data provided by the companies.

TABLE 8. SUPPLY OF COPPER PRODUCTS AND THEIR CONSUMPTION IN END USE MARKETS, 1988

United States	1988p	
	(000 t)	(% of total)
Supply		
Domestic mill products		
Building wire	487	15.5
Magnet wire	253	8.0
Communication wire	284	9.0
Other wire and cable	448	14.2
Strip, sheet, plate	422	13.4
Rod and bar	432	13.7
Tube and pipe	418	13.3
Mechanical wire	29	0.9
Foundry products	239	7.6
Powder products	20	0.6
Total	3 031	96.4
Imported mill products	113	3.6
Total supply	3 144	100.0
Uses		
Building construction	1 286	40.9
Electrical/electronic products	700	22.3
Industrial machinery/equipment	439	14.0
Transportation equipment	391	12.4
Consumer and general products	328	10.4
Total	3 144	100.0

Source: United States Copper Development Association Inc.
p Preliminary.

TABLE 9. YEARLY AVERAGE COPPER PRICES[1]

Year	LME
	(current USc lb.)
1980	99.3
1981	79.5
1982	67.2
1983	72.2
1984	62.6
1985	64.9
1986	62.3
1987	80.1
1988	118.0
1989	129.2

Source: Reuters Metal News Service.

[1] Settlement price for highest grade of copper sold.

TABLE 10. MONTHLY AVERAGE COPPER PRICES, 1988 AND 1989

	LME[1]		COMEX[2]	
	1988	1989	1988	1989
	(current USc lb.)			
January	120.8	154.2	123.2	152.2
February	105.7	140.6	99.7	134.2
March	107.0	148.2	103.9	142.9
April	103.9	141.4	97.5	138.3
May	111.0	124.4	99.3	120.7
June	115.2	115.3	109.0	109.5
July	100.4	113.4	98.8	107.2
August	99.8	125.5	96.2	121.7
September	110.5	130.7	111.2	132.0
October	133.3	130.0	133.5	125.5
November	149.9	117.5	147.1	111.5
December	158.7	109.6	155.8	103.4

Source: Reuters Metals News Service.

[1] LME settlement price for Grade A copper. [2] COMEX First Position Settlement price.

Figure 1

LONDON METAL EXCHANGE COPPER PRICES

HIGHEST GRADE SOLD

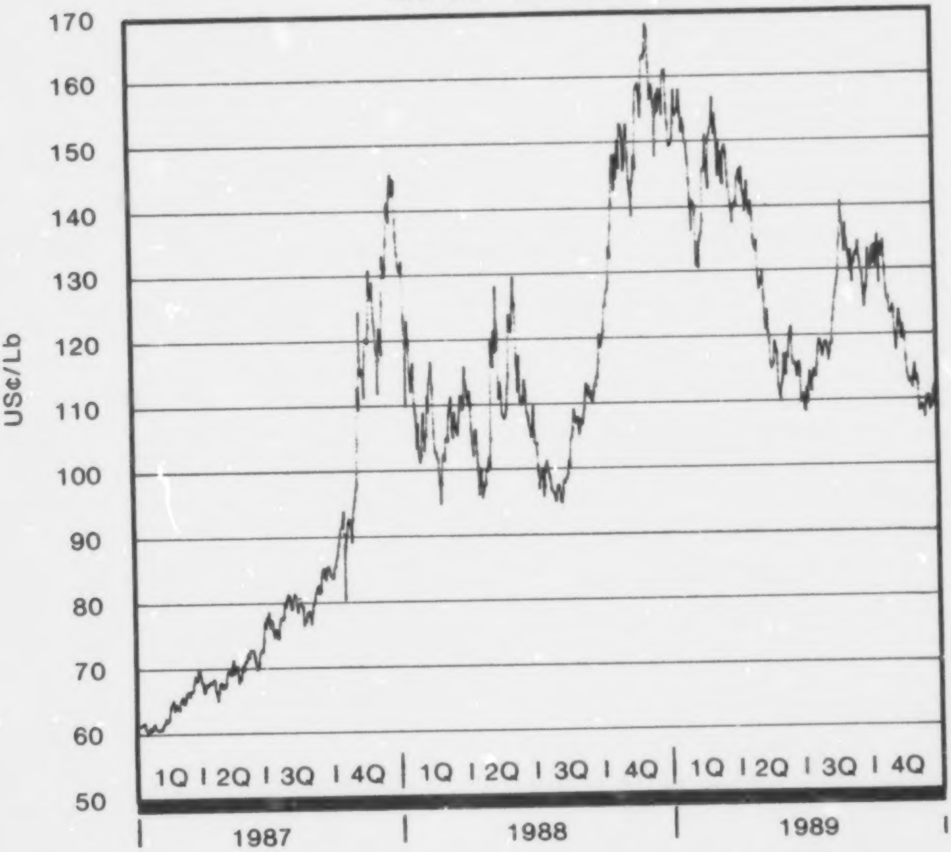


Figure 2

EXCHANGE STOCKS OF REFINED COPPER

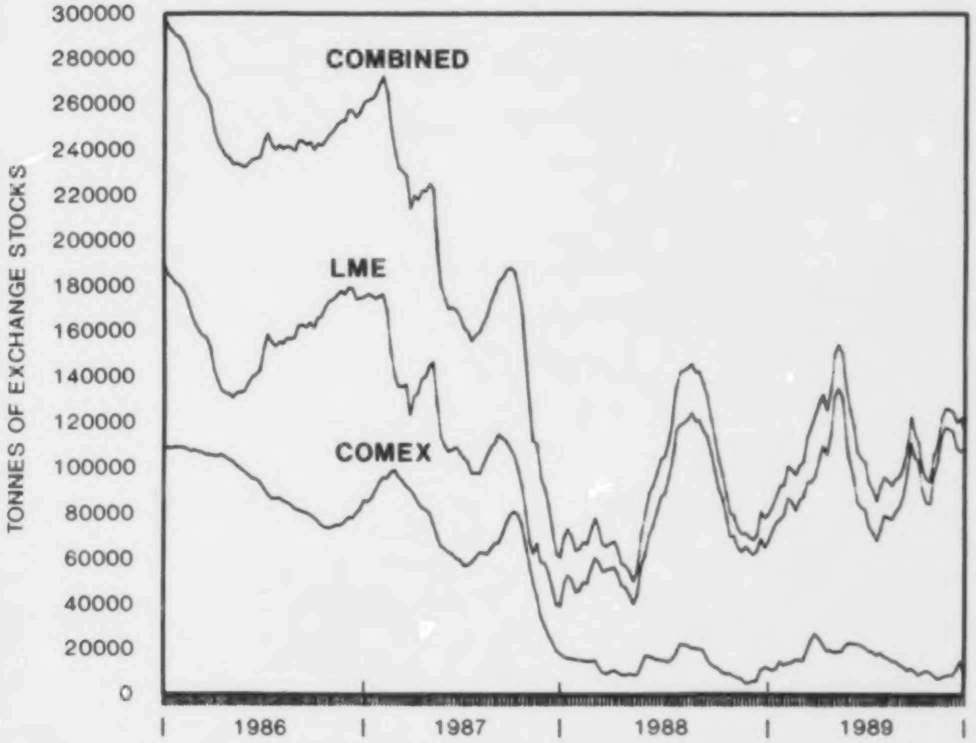
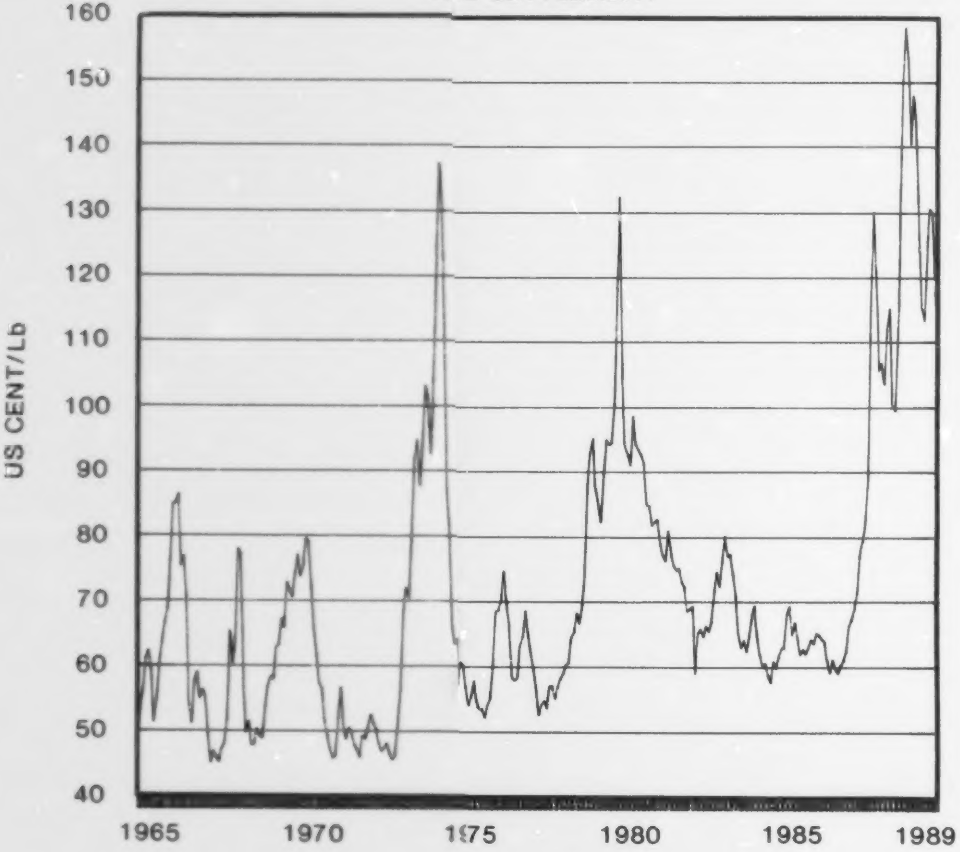
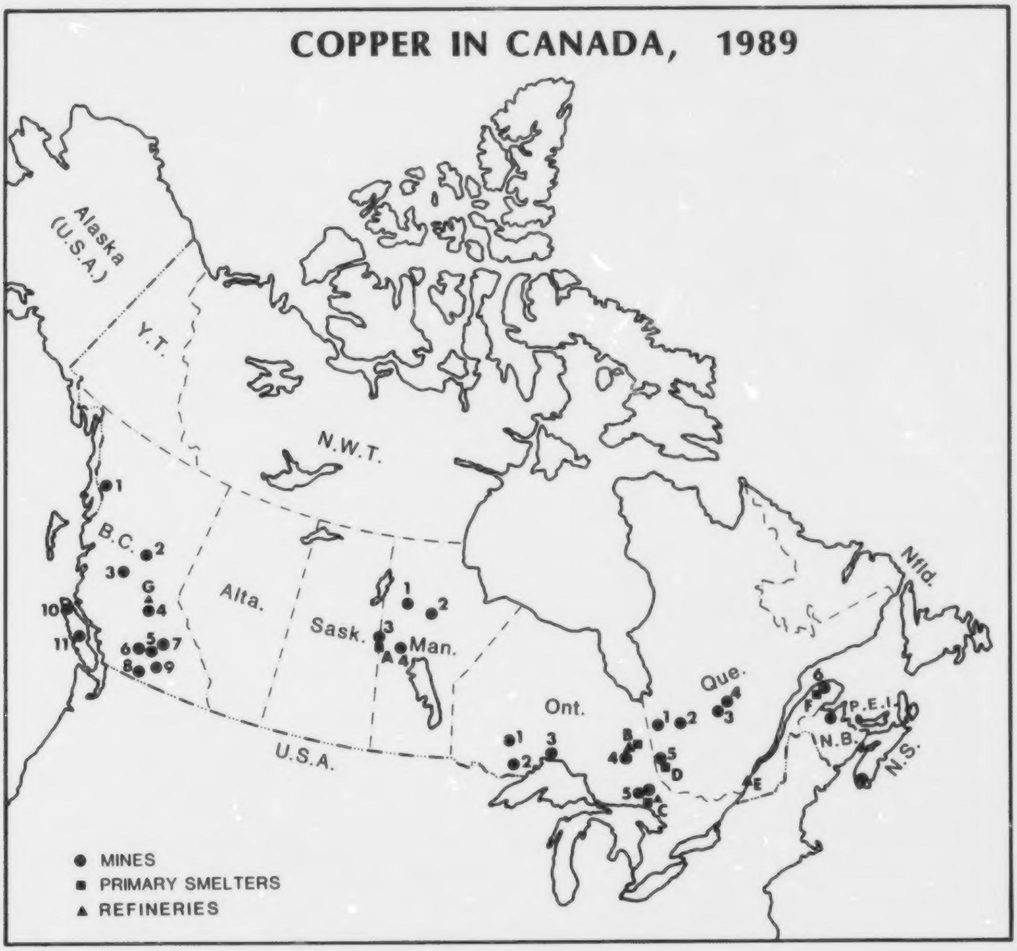


Figure 3

MONTHLY COPPER PRICES 1965-89

LME SETTLEMENT





COPPER IN CANADA, 1989

Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.A.
1
2
3
G
4
5
6
7
8
9
10
11
A
B
C
D
E
F
● MINES
■ PRIMARY SMELTERS
▲ REFINERIES

COPPER PRODUCERS IN 1989

(numbers and letters correspond to those on map "Copper in Canada 1989")

British Columbia

1. Skyline Gold Corporation (Iskut River)
2. Noranda Inc. (Bell mine)
3. Equity Silver Mines Limited
4. Gibraltar Mines Limited
5. Highland Valley Copper[1]
6. Afton Operating Corporation
7. Minnova Inc. (Samatosum)
8. Cassiar Mining Corporation (Similkameen)
9. Brenda Mines Ltd.
10. BHP-Utah Mines Ltd.
11. Westmin Resources Limited

Saskatchewan

Hudson Bay Mining and Smelting Co.,
Limited (HBMS) (Flin Flon mine)

Manitoba

1. Hudson Bay Mining and Smelting Co., Limited (HBMS), (Ruttan mine)
2. Inco Limited (Thompson mine)
3. Hudson Bay Mining and Smelting Co., Limited (HBMS), Flin Flon area mines
4. Hudson Bay Mining and Smelting Co., Limited (HBMS), Snow Lake area mines

Ontario

1. Mattabi Mines Limited (Lyon Lake mine)
2. Noranda Inc. (Geco mine)
3. Minnova Inc. (Zenmac mine)
4. Falconbridge Limited, Timmins
   Giant Yellowknife Mines Limited (Shumacher mill)
4. Falconbridge Limited (Sudbury area)
   Inco Limited (Sudbury area)

Quebec

1. Les Mines Selbaie
2. Noranda Inc. (Mattagami Lake mine)
3. Minnova Inc. Opemiska Division
4. Westminer Canada Limited
   Campbell Resources Inc.
5. Audrey Resources Inc. (Mobrun mine)
   Dumagami Mines Inc. (La Ronde mine)
   Minnova Inc. (Ansil mine)
6. Noranda Inc., Division Mines Gaspé

New Brunswick

Brunswick Mining and Smelting
Corporation Limited
Noranda Inc. (Heath Steele mine)

Nova Scotia

Rio Kemptville Tin Corporation

COPPER SMELTERS

A. Hudson Bay Mining and Smelting Co., Limited (HBMS), (Flin Flon)
B. Falconbridge Limited (Timmins)
C. Inco Limited (Sudbury area)
   Falconbridge Limited (Sudbury area)
D. Noranda Inc. (Noranda)
F. Noranda Inc. (Division Mines Gaspe)

COPPER REFINERIES

B. Falconbridge Limited (Timmins)
C. Falconbridge Limited (Sudbury area)
   Inco Limited (Sudbury area)
E. Noranda Inc. (Division CCR)
F. Gibraltar Mines Limited (SX-EW)

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[1] Highland Valley Copper is a partnership of Cominco Ltd., Teck Corporation and Rio Algom Limited.

An inventory of undeveloped Canadian copper deposits is available in the publication "Canadian Mineral Deposits Not Being Mined in 1989," Energy, Mines and Resources Canada, Report MR 223. ISBN 0-660-14371-3.

For detailed production and ore grade information, refer to the table of Nonferrous Mines following the last commodity chapter.

Fluorspar

1989

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Fluorspar is the commercial term for fluorite, a calcium fluoride mineral (CaF_2) which occurs most commonly as a vein-mineral usually associated with quartz, calcite, dolomite or barite. Fluorite is an isometric mineral which exhibits a wide range of colours from colourless to yellow, blue, green, rose and brown. It has a vitreous lustre and a hardness of four on the Mohs scale. Fluorite is the most important source of the element fluorine. Fluorite deposits are widely distributed and are mined on all continents. The world reserves base has been estimated at over 300 Mt on a 100% CaF_2 basis. Fluorspar is used in the manufacture of hydrogen fluoride (HF or hydrofluoric acid), in various metallurgical processes and in ceramic wares.

Cryolite is a sodium aluminum fluoride which is widely distributed in nature. Natural cryolite has been found in important quantities at only two localities, near Miask in the U.S.S.R. and near Ivigtut in Greenland where it was mined for several years. Natural cryolite from commercially viable deposits is now rare and has been largely replaced by synthetic cryolite obtained from hydrofluoric acid.

PRODUCTION IN CANADA

Fluorspar occurs in many geological environments from low-temperature fracture fillings to high-temperature emplacements and, as a result, it is not restricted to any particular geological province in Canada.

St. Lawrence Fluorspar Limited, a subsidiary of Minworth Ltd. of England, ran at high capacity during 1989. The operation at St. Lawrence, Newfoundland, mined and processed acid-grade fluorspar containing low arsenic and phosphorus. Fluorspar reserves have been estimated in excess of 5 Mt of fluorite ore at a grade averaging 35% CaF_2; at the current operating rate, reserves could last up to thirty years. Fluorspar ore was mined at several open pits and in the Blue Beach North underground mine, where development work continued at the 3 North and 4 South mining levels. Currently, extraction mainly occurs on the 3 South level. In 1989, the 200 t/d mill operated year round, processing several thousand tonnes of fluorite ore with improved recovery; underground mining suffered some temporary delays in production by mid-year. Environmental problems were encountered during the year relating to the tailings system and the shipping of fluorspar. Investments were made to construct an enclosed conveyer belt at the wharf for improving shiploading efficiency, and plans were undertaken for preparing adequate tailings ponds at the mine site. The operation employed close to 130 people. Acidspar (acid-grade fluorspar) concentrates, grading 97-98% CaF_2, were mainly exported to the United States.

Alcan Aluminium Limited operated its new aluminum trifluoride (AlF_3) plant at full capacity for the second consecutive year. The $135 million plant has a production capacity of 45 000 t/y and employs close to 60 people. Alcan provided AlF_3 for its own use in Arvida and sold one third of its production to Reynolds Aluminum Company of Canada Ltd. and the Aluminerie de Bécancour Inc. (A.B.I.). Alcan exported several thousand tonnes to the United States, in particular to its Kentucky-based smelter. The company imported close to 60 000 t of fluorspar from Morocco and China. It requires very pure acidspar with an extremely low amount of phosphorus which would be deleterious to its process. In expectation of higher production of primary aluminum during the 1990s, Alcan is contemplating expanding its AlF_3 production capacity in the near term. Additional experimental work was carried out for utilizing crushed tapped electrolytic bath as a secondary source of fluorine flux, which may result in lowering its needs for acidspar.

Allied Canada Limited which amalgamated into Allied-Signal Canada Inc. in 1989, Fluorine Products Division, imported acid-grade fluorspar, mainly from Mexico and the United States, for manufacturing hydrofluoric acid (HF) at Amherstburg, Ontario. The 52 000 t/y HF plant has a unique process that permits the use of high arsenic acid grade. HF is consumed captively for the manufacturing of chlorofluorocarbons (CFCs), while some tonnages were sold in the domestic market and in the United States.

Du Pont Canada Inc. continued to consume hydrofluoric acid for producing chlorofluorocarbons in Maitland, Ontario. During 1989, Du Pont announced its intention to build a $24 million commercial plant to manufacture a new hydrochlorofluorocarbon (HCFC-123). This compound is a leading candidate to replace ozone-depleting CFC-11 as a refrigeration, insulation and blowing agent. The plant is to be constructed in Maitland in 1990 for supplying the North American market by 1991-92. Its capacity has been reported at several thousand tonnes per year.

CONSUMPTION AND USES

Fluorspar is marketed in three grades according to end-use: acid grade, containing a minimum of 97% CaF_2; metallurgical grade, containing a minimum of 60% effective CaF_2; ceramic grade No. 1, containing 95-96% CaF_2; and ceramic grade No. 2, containing 85-90% CaF_2.

In 1989, the North American market for fluorspar remained firm due to sustained performances in both the aluminum and chlorofluorocarbon sectors. Consumption of fluorspar in Canada was estimated at about 180 000 t, of which 11% was metallurgical grade. Acidspar was used in the manufacture of hydrofluoric acid (63%) and aluminum trifluoride (34%). Hydrofluoric acid was sold mainly for the production of CFCs while aluminum trifluoride was used in processing primary aluminum in Quebec and British Columbia.

During 1989, the aluminum market was strong. Production of primary aluminum in Canada rose 2% to 1.56 Mt. Canadian smelters operated at full capacity for the last two years, and consumption of cryolite and acidspar increased accordingly.

The demand for acidspar in CFCs continued to be stable despite the July 1, 1989 deadline to reduce the production of ozone-depleting CFCs at 1986 levels. Sales of acidspar were particularly strong during the first half of 1989 as CFC producers operated at high capacity. However, some slowdown prevailed in the second half which lowered the rate of consumption growth for acidspar.

The pricing of acidspar in North America showed a gradual increase during the period 1987 to 1989. Prices quoted on an f.o.b. works basis rose 25% to range between US$133-145/t. Price premiums for quality were reported to be marginal.

Acid grade

Roughly 50% of the world's fluorspar requirements are for acid grade, used in the manufacture of hydrofluoric acid. Hydrofluoric acid has a variety of uses, but by far the most important is in the chemical and aluminum industries, which together account for some 80% of consumption.

Close to 50% of hydrofluoric acid consumed in Canada was used in the manufacture of chlorofluorocarbons (CFCs). CFCs are synthetic chemicals which are very stable, non-flammable, non-toxic and non-carcinogenic for use in numerous applications. Four CFCs (-11, -12, -22 and -113) accounted for 95% of all CFCs produced. In 1987-88, Canada consumed close to 23 000 t of CFCs requiring about 45 000 t of hydrofluoric acid. HF was principally sourced in Canada from the processing of imported Mexican acidspar. The two major CFCs (-11 and -12) accounted for two thirds of total CFC production, the remaining 33% included CFC-113 and HCFC-22. In Canada, chlorofluorocarbons are mainly used as refrigerants (CFC-11, -12 and -22) for industrial and consumer equipment and air conditioning units (45%); as a blowing agent for plastic foam (40%); as solvents (CFC -113) for micro-electronic circuitry (10%); and as sterilizants (CFC -12) for medical supplies (5%).

In recent years, scientists determined that chlorine from fully halogenated CFCs is the primary factor in the depletion of the stratospheric ozone layer which protects the earth from solar ultraviolet radiation. Long-life chlorofluorocarbons such as CFC -11, -12 and -113 are frequently used and released into the atmosphere. When reaching the stratosphere, these compounds break down due to intense solar radiation and liberate free chlorine which catalyzes ozone destruction. A single molecule of chlorine can destroy up to 100 000 ozone molecules. The thinning of the ozone layer could lead to increases in skin cancer and cataracts, and is reported to contribute to global warming.

In September 1987, member countries of the United Nations Environment Program (UNEP) agreed in Montreal on a Protocol on Substances that Deplete the Ozone Layer. By January 1989, more than 45 countries ratified the international convention proposing to freeze the consumption and production at 1986 levels by July 1989, followed by a 20% reduction by mid-1993 and an additional 30% reduction by mid-1998. The control measures apply to predominantly used

CFCs (-11, -12, -113, -114 and -115) and Halons (-1211, -1301 and -2402). The protocol came into force on January 1, 1989. However, in June 1990, a new round of discussions under the auspices of UNEP will be held in England and is expected to call for more stringent regulations demanding a complete phase-out of these CFCs by the year 2000.

In early 1989, the Canadian government announced its decision to issue regulations to curb the use of CFCs in Canada by 85% before 1999. Similarly, several provincial governments, such as Ontario, and major municipalities, such as Toronto and Montreal, called for a ban on the production, use and sale of ozone-depleting chemicals by 1998. As well, many industrial companies in North America have vowed to curtail the consumption of hard CFCs and to promote the use of substitutes.

For the last ten years, CFC producers have been developing new chemical products of which some substitutes, the so-called soft CFCs (hydrofluorocarbon - HFC and hydrochlorofluorocarbon - HCFC), will contain more fluorine. However, these alternatives could be commercially available only, at the earliest, in 1992 since toxicity tests take 5-8 years to be completed. Incidentally, a consortium of close to 15 world producers of CFCs was formed in 1988 to initiate common toxicity tests under a new Program for Alternatives Fluorocarbons Toxicity Testing (PAFTT) for accelerating the completion and the release of results. Long-term carcinogenicity studies started in 1989 for completion by 1992-93; meanwhile, preliminary results released late in 1989 have shown that the three leading alternatives (HCF-134a, HCFC-123 and HCFC-141b) demonstrated no significant toxicity in short-term tests. The consortium also sponsored a research study reviewing the current scientific information on the effect of the potential substitutes on stratospheric ozone, the Alternative Fluorocarbons Environmental Acceptability Study (AFEAS); the results showed that new HCFCs and HFCs have one tenth or less of the effect on ozone depletion compared to the current hard CFCs. While the quest for acceptable substitutes has focussed on three compounds, other chemicals such as carbon tetrachloride and methyl chloroform are facing pressures for inclusion in the UNEP protocol.

Between 15% and 30% of all hydrofluoric acid is used by the aluminum industry. Hydrofluoric acid is used in the manufacture of synthetic cryolite, an essential cell ingredient for fluxing in the electrolytic reduction of alumina to aluminum. The acid is also used to produce aluminum trifluoride (AlF_3) which lowers the melting point of the electrolyte in the refining process. In 1988, the consumption of aluminum trifluoride in Canada was estimated at 35 825 t. Quebec accounted for more than 80% of this consumption, with the remainder being used in British Columbia. Quebec smelters sourced their requirements in AlF_3 partially from domestic suppliers, while in British Columbia, AlF_3 was imported from Norway (75%) and Japan (25%). The consumption of AlF_3 per tonne of aluminum produced averaged 23.7 kg/t. This ratio differed between modern smelters (closer to 15 kg/t) and older plants (near 30 kg/t).

Hydrofluoric acid is used in uranium refining, in the manufacture of alkylate for high octane fuel, in steel pickling, enamel stripping, glass etching and electroplating.

Metallurgical grade

About one half of the world's fluorspar production is consumed as a metallurgical fluxing agent (metspar), primarily in the manufacture of steel where it is used to remove impurities during melting and also to improve separation of metal and slag in the furnace by increasing the fluidity of the slag.

More fluorspar is being recycled because of environmental constraints which are forcing plants to reduce emissions; this also tends to promote the use of substitutes such as olivine and dolomitic limestone in some countries.

Ceramic grade

Ceramic-grade fluorspar is used as flux and as an opacifier in enamels, flint glass and white or opal glass. It is also used in the manufacture of glass fibre insulation.

CANADIAN TRADE OF FLUORINE COMPOUNDS

In 1988, fluorspar imports in Canada rose 44% to 194 057 t, valued at $26.4 million. Acidspar accounted for close to 90% of total fluorspar imports. One third of all imports went to Quebec and these were mainly from China and Morocco, while shipments to Ontario were from Mexico and the United States. Aluminum trifluoride imports were shipped to Quebec (56%) and British Columbia (44%), and hydrofluoric acid was imported mostly by Ontario. All exports of HF and

AlF_3 were shipped to the United States and amounted to about 89 000 t of acidspar equivalent.

In the first nine months of 1989, imports of acidspar reached 81 578 t and were for Ontario (60%) and Quebec (40%). The unit value of imported acidspar rose 6% to $142.44/t. Only five countries supplied fluorspar in Canada; Mexico remained the leading supplier with a 66% share, followed by Morocco (19%) and China (6%). Natural cryolite was imported from the United States by Ontario (64%) and Quebec (36%), with an average unit value of $494.80/t. Exports of HF were from Ontario to the United States and had a unit value of $1364/t. Exports of AlF_3 were from Quebec to the United States; the unit value rose 7% to $1210/t.

WORLD PRODUCTION

In 1989, world production of fluorspar rose 5% to 5.43 Mt. China was the largest producer, accounting for 20% of world production, followed by Mexico (16%), Mongolia (14%), and the U.S.S.R. (10%). In 1988, acid-grade fluorspar contributed one half of world output and was primarily produced in China (25%), Mexico (16%), the Republic of South Africa (11%), the U.S.S.R. (10%) and Spain (9%). Canada ranked as the fifteenth producer of acidspar in 1988. By year-end 1988, world production capacity was estimated at 7.56 Mt/y by the U.S. Bureau of Mines; world producers operated at 71% of capacity during 1989.

United States

In 1989, production of fluorspar was estimated at 63 000 t, a flat level for over the last three years. Fluorine compounds were also produced as fluosilicic acid (FSA) by nine phosphoric acid plants, and production reached 54 000 t of FSA or 92 000 t of fluorspar equivalent. Illinois was the major producing state of fluorspar accounting for over 90% of all domestic shipments. Ozark-Mahoning Co., a subsidiary of Pennwalt Corporation, operated two mines and a flotation plant in Pope and Harding Counties, Illinois. In 1989, Ozark-Mahoning acquired some holdings of Inverness Mining Co., including the former Minerva N.1 Mine in Harding County; dewatering and development work was carried out for mining to resume in 1989-90. Several other companies operated fluorspar plants: Hastie Trucking and Mining Co. and Inverness Mining Co. in Cave-In-Rock (Illinois), J. Irving Growell Jr. & Son in Nye County (Nevada), and Kentucky Illinois Fluorspar Co. near Salem (Kentucky).

Imports of acidspar and metspar were 517 000 t and 136 000 t respectively. Imported acidspar declined 5% from 1988 and was mainly from Mexico (38%), China (23%) the Republic of South Africa (21%), Canada (9%) and Morocco (6%). With minimal exports of fluorspar, the reported consumption of acidspar increased 9% to 450 000 t for use mainly in hydrofluoric acid (72%). The net import reliance as a percentage of apparent consumption remained steady at 91%. The unit value of imported acidspar rose 15% from US$96.01/short ton late in 1988 to US$110.00/short ton by the end of the third quarter in 1989.

During 1988 and 1989, several U.S. companies announced expansion or construction of new HCFC plants: Halocarbon Products Corporation in Hackensack, New Jersey started to produce experimental HCFC 123 and HFC-134a during 1989; E.I. du Pont de Nemours and Company is to construct a commercial plant for HFC-134a in Corpus Christi (Texas) and a pilot plant for HFC-134a in Ponca City (Oklahoma), and is to convert the Montague Plant in Michigan to produce HCFC-141b; Allied Chemical Company put on-stream a pilot plant for HCF-134a and a pilot plant for HCFC-141b in Buffalo; Pennwalt Corporation commissioned a new 22 000 t/y HCFC-142b plant in Thorofare, New Jersey; and ICI Americas Inc. announced its decision to build a commercial plant for HFC-134a near St. Gabriel, Louisiana.

During 1985, Atochem Inc. of Glenn Rock (New Jersey) acquired the assets of Pennwalt Corporation, which owned a 65 000 t/y CFC plant in Calvert City. Atochem Inc. is a subsidiary of Société Nationale Elf Aquitaine of France. In 1988, Atochem purchased Racon Inc., a former CFCs producer with a 45 000 t/y plant in Kansas. Late in 1988, Allied Chemical shut down its HCFC-22 plant near Elizabeth, New Jersey, due to environmental problems with waste effluents. La Roche Chemicals purchased the 35 000 t/y CFC plant of Kaiser Aluminum & Chemical Corporation in Gramercy (Louisiana) in mid-1988.

China

China remained the largest world producer of acidspar accounting for 25% of world output. Production in 1989 was estimated at 777 000 t. Close to 37 plants or mills were active in 13 different provinces, of which Hunan was the leading producing province with a 29% share, followed by Zhejiang (20%) and Shadong (19%). Most of the Chinese production was for export through the Port of Shanghai for deliveries to Japan (33%), North America (16%), Western Europe (10%) and Oceania. Proven reserves of fluorspar have been estimated in excess of 50 Mt. In 1985, the consumption of fluorspar was estimated to be around 225 000 t and is expected to double by the year 2000. Further expansions are forecast for maintaining or increasing China's exports above the 500 000-600 000 t range.

In Brazil, Mineração Nossa Senhora do Carmo Ltda based in Criciuma announced its intention to build a 20 000 t/y processing plant to produce metallurgical grade in the State of Parana; completion is due by 1991. SA Indústrias Votarantim will construct a new fluorspar-processing plant near Adrianopolis for production by 1993. Mineração Del Rey, a subsidiary of E.I. du Pont de Nemours and Company of the United States, commissioned a new US$17 million acidspar operation in Cerrol Azul, 160 km from Curitiba in Parana State; the 60 000 t/y plant is supplied with a head feed grading 60% CaF_2. Reserves were estimated at 2.8 Mt. Close to 75% of production is expected to be exported to du Pont's plant in Texas.

In Groenland, Kryoliteselkabet Oresund A/S of Denmark shut down indefinitely its natural cryolite operation near Ivigtut. In Mongolia, a new metspar-processing plant opened near Bornum, with an annual capacity of 110 000 t/y of concentrate. In Mexico, Cia. Minera Las Cuevas S A de C V completed its expansion at the San Luis Potosi operation, increasing acid-grade capacity to 320 000 t/y and metspar gravel capacity to 200 000 t/y; Fluorex, one of its subsidiaries, installed a new 10 000 t/y arsenic removal unit for hydrofluoric acid in Juares. In Namibia, Okorusu Flurospar Pty Ltd. commissioned a new 50 000 t/y acidspar plant near Okorusu Mountain during 1988; reserves were estimated at 5.9 Mt grading 56% CaF_2.

OUTLOOK

In 1990, it is expected that acidspar demand will remain stable providing the ozone-depleting chemicals are gradually replaced by acceptable and efficient alternatives. The CFC market in North America is expected to be tight due to production capped at 1986 levels. A quota system for allocating sales to buyers is being considered in the United States. The price of acidspar is forecast to increase between 5-8% in 1990, ranging between US$130-$150/t on an f.o.b. work basis, due to the limited availability of high quality grade.

Acid-grade fluorspar is likely to maintain its current level of consumption in the aluminum sector. The increasing production for primary aluminum in Canada should offset the trends for lower consumption of aluminum trifluoride per tonne of aluminum produced and for the recycling of cryolite and fluorine fumes. In Canada, several new smelting capacities were announced over the last two years; from a 1988 basis, the Canadian annual nameplate capacity for the production of primary aluminum is forecast to increase 30% to 2.07 Mt/y by 1992, followed by an additional 28% to 2.52 Mt by the year 2000. Although aluminum output will increase accordingly, there is no short-term expectation that the consumption of AlF_3 will follow this trend proportionally. The introduction of new, efficient technology for new smelters and the mothballing of older and less efficient plants in Canada will result in a lower growth rate in the demand for AlF_3. The Canadian average consumption of AlF_3 per tonne of aluminum produced is estimated at 20 kg/t by 1992 and at 18.5 kg/t by the year 2000. Accordingly, the domestic consumption of acidspar in the Canadian aluminum industry is forecast to remain flat at the 1988 level up to the year 1992; thereafter, a 30% increase would result in the consumption of 70 000-75 000 t/y by the year 2000. The future of the demand for acidspar is increasingly tied up with the projected consumption of chlorofluorocarbons and their substitutes. With mounting concerns over the stratospheric ozone depletion issue, calls for stronger regulations for prohibiting production, consumption and trade of selected CFCs are accelerating the quest for non-chlorine, non-halogenated alternatives. However, the availability of new substitutes assumes favourable toxicity and carcinogenicity testings as well as successful process development and adequate plant design. The time-frame for new chemicals to enter the marketplace is between 1991 and 1994. However, potential regulations on some alternatives are already being contemplated by many nations. The 50% cut by 1999 is likely to be amended under the Montreal protocol for a complete phase-out before the end of the century. Sufficient technology is available for a 95-98% phase-out of the five controlled CFCs by the year 2000.

The replacement compounds are reported to be more expensive and, to a certain extent, less effective than the original chemicals. The timing of the substitution of CFCs will likely be dictated by the user's industry rather than the producing industry since the existing equipment, i.e., refrigerator and air-conditioning units in houses and cars, cannot operate with the new substitutes. New technologies are being developed for recycling CFCs and for adapting new compounds in conventional systems by formulating new lubricants and by modifying equipment.

The demand for acidspar in this application will be influenced by the higher fluorine content in the new fluorocarbons and hydrochlorofluorocarbons. The fluorocarbon/acidspar ratio (F/A ratio) is expected to increase drastically; the F/A ratio for CFC-11 averages 1:0.3, and 1:0.7 for CFC-12. The new generation of fluorocarbons has a much higher ratio: 1:1.0 for HCFC-22 and HCFC-123; 1:0.4 for HCFC-141b; 1:0.9 for HCFC-142b; and 1:3.0 for HFC-134a. Depending on the allocation of the substitution for CFC-11, -12 and -113, the demand for acidspar could as much as triple before the year 2000.

The numerous announcements for the construction of several new fluorocarbon plants in North America demonstrate the strong commitments of the chemical industry to respond to this environmental and commercial issue. The medium-to-long-term outlook for acidspar looks excellent and bodes well for hydrofluoric acid and high-grade fluorspar producers.

Note: *Information contained in this review was current as of mid-January 1990.*

PRICES

	1987	1988	1989
Fluorspar		(US$/tonne)	
Mexico, f.o.b. Tampico			
Acid grade, filtercake	110	115-120	130-135
Metallurgical grade	50	70-77	90
South Africa, f.o.b. Durban			
Acid grade, dry basis	100-110	115-120	130-140
United States, f.o.b. Illinois			
Acid grade, bulk	168-173	168-173	168-173
Hydrofluoric Acid		(C$/kg)	
Canada, f.o.b. Amherstburg			
Anhydrous 100%, tanks	2.04	2.04	2.04
Aqueous 70%, tanks	1.60	1.60	1.60
		(US$/lb.)	
United States, f.o.b. plant			
Aqueous 70%, tanks	0.43	0.43	0.43
Anhydrous 100% tanks	0.6875	0.6875	0.6875

Sources: Industrial Minerals; Corpus Chemical Report; Chemical Marketing Reporter.
f.o.b. Free on board.

TARIFFS

		Canada			United States
Item No.	Description	MFN	GPT	USA	Canada
2529.22.00	Fluorspar, containing by weight more than 97% of calcium fluoride	Free	Free	Free	US$2.07/t
2529.21.00	Fluorspar, containing by weight 97% or less of calcium fluoride	Free	Free	Free	13.5%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1A. CANADA, FLUORSPAR SHIPMENTS AND TRADE, 1985-87

	1985		1986		1987	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Shipments						
Fluorspar	0	0	0	0	(1)	(1)
Imports						
Cryolite, Natural						
United States	64	39	1 156	805	1 045	720
Netherlands	218	102	251	123	7 332	251
Denmark	236	115	218	126	230	136
France	0	0	1 912	1 538	0	0
Total	518	257	3 537	2 592	8 607	1 107
Cryolite, Synthetic						
United States	8 230	6 688	3 492	2 681	2 967	2 400
Other countries	1 161	1 013	9 077	7 163	0	0
Total	9 391	7 701	12 569	9 844	2 967	2 400
Fluorspar						
Mexico	67 584	9 059	87 620	11 340	66 587	7 640
Morocco	18 277	2 679	33 089	4 484	22 500	3 209
China	0	0	4 882	507	14 433	1 753
Italy	0	0	0	0	7 805	976
United States	7 578	2 093	10 635r	2 388	8 991	2 244
Spain	18 287	2 646	27 654	3 969	14 251	2 034
Nicaragua	0	0	0	0	0	0
France	0	0	234	71	0	0
Total	111 726	16 477	164 114	22 759	134 567	17 857
Hydrofluoric Acid						
United States	383	558	1 231r	1 456r	5 169	4 520
Japan	141	122	171	175	141	130
United Kingdom	86	96	220	224	70	69
West Germany	6	5	2	2	20	8
Total	616	780	1 624r	1 857r	5 400	4 727

Sources: Energy Mines and Resources Canada; Statistics Canada.
(1) Confidential.
r Revised.
Note: Totals may not add due to rounding.

TABLE 1B. CANADA, FLUORSPAR SHIPMENTS AND TRADE, 1988 AND 1989

		1988		1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Shipments					
Fluorspar		(1)	(1)	(1)	(1)
Imports				(Jan.-Sept.)	
2527.00	Natural cryolite; natural chiolite				
	United States	568	268	3 411	1 687
	Denmark	268	148	228	106
	Netherlands	281	352	82	128
	Germany, West	0	0	11	17
	Total	1 117	768	3 732	1 940
2826.30	Sodium hexafluoroaluminate (synthetic cryolite)				
	United States	1 395	866	769	493
	Total	1 395	866	769	493
2529.21	Fluorspar, containing by weight 97% or less of calcium fluoride				
	United States	7 982	1 482	2 723	486
	China	12 857^{2}	1 726^{2}	0	0
	Mexico	12 750	1 621	8 097	1 026
	Total	33 589	4 831	10 820	1 512
2529.22	Fluorspar, containing by weight more than 97% of calcium fluoride				
	United States	4 420	1 092	3 742	881
	Morocco	34 000	4 863	15 000	2 358
	China	14 063	1 915	10 242	1 424
	Mexico	107 985	13 679	52 594	6 956
	Total	160 468	21 549	81 578	11 620
2811.11	Hydrogen fluoride (hydrofluoric acid)				
	United States	4 412^{r}	4 492^{r}	2 096	2 092
	United Kingdom	205	222	106	115
	Germany, West	6	3	3	5
	Japan	44	56	16	16
	Other	8	13	0	0
	Total	4 674^{r}	4 788^{r}	2 220	2 229
2826.12	Aluminum fluoride				
	Norway	6 802	6 315	4 476	4 737
	France	1 333	1 577	1 431	1 629
	Spain	80	90	784	888
	Japan	1 000	928	500	537
	Other	90^{r}	124^{r}	68	83
	Total	9 305	9 034	7 259	7 874

Sources: Energy Mines and Resources Canada; Statistics Canada.
(1) Confidential; ^{2} Figures under revision.
^{p} Preliminary; ^{r} Revised.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, FLUORSPAR REPORTED CONSUMPTION, 1986-88

Reported Consumption[1]	1986	1987	1988[p]
		(tonnes)	
Metallurgical flux	17 648	19 560	16 172
Foundries	4 765	8 890	5 850
Other[2]	124 664	151 145	157 131
Total	147 077	179 595	179 193

[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants. [2] Includes consumption in the production of aluminum, chemicals, and other miscellaneous uses.
[p] Preliminary.

TABLE 3. MAJOR CONSUMERS OF FLUORSPAR BY GRADE IN CANADA

Product	Major Consumers
Metallurgical grade (used as gravel or briquettes)	Stelco Inc. Ford Motor Company of Canada, Limited Sydney Steel Corporation Dofasco Inc. Atlas Specialty Steels Division of Rio Algom Limited
Ceramic grade (used as powder)	The Algoma Steel Corporation, Limited Ferro Industrial Products Limited A.P. Green Refractories
Acid grade (used as powder or hydrofluoric acid)	Alcan Aluminium Limited Du Pont Canada Inc. Allied-Signal Canada Inc. Timminco Limited

Source: Energy, Mines and Resources Canada.

TABLE 4. WORLD ALL-GRADE FLUORSPAR PRODUCTION 1984-89

	1984^{r}	1985^{r}	1986^{r}	1987^{p}	1988^{p}	1989^{e}
	(000 tonnes)					
People's Republic of China	750	935	900	1 000	1 100	1 090
Mexico	700	730	765	825	775	860
Mongolia	740	740	780	780	790	790
U.S.S.R.	550	560	560	560	560	565
South Africa	320	350	335	315	335	370
Spain	295	305	280	255	265	255
France	230	225	200	200	200	200
United Kingdom	135	165	135	140	145	145
Italy	190	150	145	145	145	145
Thailand	290	330	170	100	100	115
Kenya	45	60	50	60	60	100
United States	65	60	70	65	65	65
Other countries[1]	520	485	620	510	635	735
Total	4 830	5 095	5 010	4 955	5 175	5 435

Source: U.S. Bureau of Mines, 1989 Fluorspar, M. Miller.

[1] Comprises production for other important producers such as Argentina, Brazil, Canada, Czechoslovakia, West Germany, North Korea and Morocco.

^{e} Estimated; ^{p} Preliminary; ^{r} Revised.

Gallium

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Gallium is usually associated with bauxite, the raw material for aluminum, and is extracted from Bayor liquor, the feedstock derived from the alumina refining process. Gallium can also be extracted from sphalerite, the economically valuable mineral of zinc sulphide ores. The start-up of a gallium-germanium operation in the United States in 1986 represented the first mine that produced these elements as its principal products. Gallium is also recovered from scrap.

Gallium melts at 29.8°C, i.e. below body temperature, a lower melting point than any other metal other than mercury and cesium, but does not boil until 2403°C. Thus, gallium metal is a liquid over an exceptionally wide temperature range.

Gallium in combination with phosphorus, antimony or arsenic, forms compounds that possess semiconductor properties; hence, the metal's main application in electronics.

DOMESTIC

In 1989, Alcan Aluminium Limited officially announced its decision to withdraw from the production of gallium metal and the manufacture of gallium arsenide semiconductor chips due to poor market growth forecasts for these chips. Technical problems associated with the production and recycling of gallium metal were also reported to be behind Alcan's decision.

As a result, Alcan closed its 15 t/y gallium scrap reclamation plant which was commissioned in 1987 near its research and development (R&D) and rolling mill operations in Kingston, Ontario. Also closed was a 5 t/y gallium recovery demonstration plant that was only completed in January 1988 at Alcan's Jonquière, Quebec alumina processing and aluminum smelting complex. Alcan had originally intended to increase the demonstration plant's recovery capacity to that of a full-scale operation of around 15-20 t/y.

Alcan also sold it's gallium refining operation in Rorschach, Switzerland to Rhône-Poulenc SA of France. The Swiss plant was originally purchased by Alcan in 1985 from Alusuisse Metals, Inc.

In October 1988, Cominco Ltd. sold its Electronic Materials Division to Johnson Matthey Public Limited Company of the United Kingdom for $40 million. Canadian regulatory authorities approved the sale in December. Included in the sale were Cominco's rare metals production plant at Trail, British Columbia, which provides electronic grade metals at a purity above 4N (99.99%), and its research facilities at Victoria, British Columbia and at Spokane, Washington.

Johnson Matthey will continue to conduct research and development on gallium and gallium arsenide at Cominco's former facilities at Trail, British Columbia. Cominco's research had led to innovations in the technology of gallium purification and in the manufacture of compound semiconductors, including those made of gallium arsenide.

Elsewhere on the R&D front, Bell Northern Research Ltd. of Nepean, Ontario, conducted a $7.5 million research project on gallium arsenide for the National Research Council of Canada.

WORLD

World consumption of gallium is estimated at 60 t/y. Japan's consumption is reported to be approximately 40 t/y, with the United States accounting for 15 t/y and Europe for 5 t/y.

Responding to an anticipated rapid growth in demand for gallium arsenide semiconductors, new gallium recovery plants came on-stream in 1989, boosting primary world production capacity to an estimated 110 t/y.

In Australia, Rhône-Poulenc commissioned a 50 t/y capacity at Pinjarra during the month of April 1989. Feed material for this plant will be in the form of Bayor liquor from the adjacent Aluminum Company of America (Alcoa) alumina refinery. Gallium metal from the Pinjarra plant will be further refined at Rhône-Poulenc's Salindres facility in France. Once the Pinjarra plant reaches capacity, Rhône-Poulenc will close its gallium recovery plant at Pechiney Électrométallurgie's Gardenne alumina plant in France.

Rhône-Poulenc announced the creation of a joint venture with Spain's state-owned company, Industria Española del Aluminio S.A. (Inespal), to produce an estimated 30 t/y of gallium from Inespal's alumina refinery in San Ciprian, Spain.

With the purchase of Alcan's Alusuisse purification facility and the Australian and Spanish extraction plants, Rhône-Poulenc will dominate the gallium market worldwide.

Hecla Mining Company, headquartered in Coeur d'Alene, Idaho, recently bought the dormant Apex mine at St. George, Utah from Musto Explorations Limited. Production of gallium-germanium is expected to resume in early 1990. The Apex plant had encountered a number of technical problems with the extraction of germanium and gallium; however, since Hecla took over the operation it has made a number of process engineering changes and hopes to operate the new facility profitably. Production capacity of this operation will be more than 20 t/y of germanium contained in sodium germinate, and 7 t/y of gallium metal.

Billiton International Metals B.V. announced that it will construct a new 20 t/y gallium plant at Stade, West Germany. The plant, a 50:50 joint venture between Billiton Witmetal and Vereinigte Aluminium-Werke AG (VAW), was expected to be fully operational by mid-1989.

The 1988 merger of France's Société minière et métallurgique de Peñarroya S.A. (Peñarroya) with West Germany's Preussag AG created a new company called Metaleurop SA. Metaleurop SA announced that it planned to increase its annual capacity for recovering gallium from gallium arsenide scrap to 10 t/y by 1989 from the previous level of 1 t/y.

As well, minor expansion projects were reported in Eastern Europe, such as a 4 t/y increase by the Hungarian Aluminum Corp. in Ajka and a 2 t/y increase at the Zavod plant in Ziar, Czechoslovakia.

In the United States, Spectrum Technology, Inc. decided to close its gallium arsenide wafer operation. Assets of Spectrum were taken over by M/A-COM's Inc., which intends to increase its U.S. market share. Imperial Chemical Industries plc (ICI) of the United Kingdom announced that it will also sell its interests in gallium arsenide wafer production. Both Spectrum Technology and ICI have abandoned their gallium arsenide interests because growth in demand for wafers was just a fraction of what had been projected about five years ago.

CONSUMPTION AND MARKETS

Gallium is consumed almost entirely in the form of gallium arsenide or gallium phosphide. The major growth area for gallium is expected to be in semiconductors; gallium arsenide (GaAs) is estimated to perform at 10 times the speed of silicon. GaAs accommodates more transistors per wafer, operates at much higher temperatures, consumes less power and provides higher resistance to radiation in military and space applications. The properties of gallium arsenide provide many business development opportunities such as the replacement of silicon chips in mini super-computers that would require special cooling under high-speed utilization. Also, GaAs has good potential for battery-powered systems, because it consumes less power than silicon.

Increasing the diameter of gallium arsenide wafers from two to four inches, thus allowing for more chips, has resulted in a major reduction in manufacturing costs and the production of more chips. Another advantage of GaAs over silicon is its more efficient absorption of sunlight, resulting in better solar cells. Since it also emits light, it can combine the functions of processing light and electronic data on a single chip.

The major obstacle to GaAs never attaining market projections to replace silicon has been its price; currently it is 30 times that of silicon. GaAs is also reported to be fragile and difficult to work with. The western world's market for gallium arsenide chips is currently reported to be around US$100 million, compared to the US$2 billion that had been predicted in the early 1980s. In comparison, the silicon chip market is worth around US$30 billion.

Other uses for GaAs are in optoelectronic applications such as light-emitting diodes (LEDs) and lasers. Most LEDs applications require little GaAs. However, this application could grow significantly if automobile manufacturers follow Nissan's decision to use LEDs for rear brake lights on some of its recent models. GaAs is also used in electronic devices like laser diodes, important in fibre-optic communication systems and consumer electronic equipment such as compact disc players, and in diodes for microwave applications, notably in certain types of radars and in direct broadcast satellite receivers where high-frequency performance is superior to silicon devices.

Experimental research is currently being conducted on the use of gallium as a treatment for osteoporosis. Osteoporosis is a disease that causes bone resorption in older women. If such a treatment proves effective, gallium consumption could increase by several tonnes annually.

Large quantities of gallium metal will be needed over the next three years for the European neutrino project in Italy, as well as for the Soviet and American joint neutrino project in the U.S.S.R. The West European project is expected to require some 30 t of gallium, while the Soviet and American joint neutrino project in the U.S.S.R. will need about 60 t. Neutrinos are sub-atomic particles thought to be liberated by the energy-generating nuclear reactions in the core of the sun and other stars. Studying neutrinos is thought to be the best way to understand reactions in the sun's core where solar energy originates. In Canada, a $61 million observatory, sponsored mainly by the National Research Council of Canada, will be built 2 km underground at Inco Limited's Creighton mine in Sudbury. The Canadian neutrino experiment will not require any gallium.

PRICES

Quoted prices for 99.99% (4N) gallium metal in the American metal market have remained stable at around US$435/kg for the past three years.

OUTLOOK

Rapid growth in demand for gallium has been expected for some time. However, this has been slow to materialize as large demand volumes for gallium arsenide by the semiconductor industry is not expected before the mid-1990s. Consumption is only expected to reach 100 t/y by 1995, significantly lower than earlier forecasts of 400-500 t/y. Demand will be associated with new technologies related to integrated circuits applications using GaAs, which still need further development. However, silicon chip manufacturers have continued to make advances and have introduced some major improvements to the product over the last few years, such as increased speed, making GaAs wafers less attractive.

With additional new and planned production capacity coming on-stream, world prices could be severely depressed if the forecasted demand growth for gallium arsenide in semiconductor applications does not materialize in the near future.

The relatively high price of GaAs technology in relation to the more common silicon-based chips has limited the current market for GaAs to high-speed and expensive computers. However, a larger supply of GaAs at a lower price could generate more demand in this application area.

Optoelectronic applications offer better prospects for gallium in the medium term. It is already used in light-emitting diodes and laser applications will grow in importance with fibre optics. However, for certain applications, one kg of GaAs can make up to 500 000 LEDs. Growth rates of 15% to 25% are expected for overall LEDs consumption, but this is considerably down from earlier, more optimistic forecasts.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

		Canada			United States
Item No.	Description	MFN	GPT	USA	Canada
8112.91.10	Gallium, unwrought metal, not alloyed; powders, not alloyed	4%	Free	2.4%	2.9%
8112.91.20.11	Gallium, unwrought metal, alloyed; waste and scrap; powders, alloyed	10.2%	6.5%	6.1%	2.9%
8112.99.90.10	Gallium, n.e.s.	10.2%	6.5%	6.1%	4.4%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.
n.e.s. Not elsewhere specified.

TABLE 1. CANADA, GALLIUM IMPORTS, 1988 AND 1989

Item No.		1988		Jan.-Sept. 1989p	
		(kilograms)	($000)	(kilograms)	($000)
8112.91.10.10	Gallium, unwrought, not alloyed; powders				
	United States	543	27	218	34
	Total	543	27	218	34
8112.91.20.11	Gallium, unwrought, alloyed; waste and scrap; powders, alloyed				
	United States	591	82	11	2
	Total	591	82	11	2
8112.99.90.10	Gallium and articles thereof, n.e.s.				
	United States	676	54	24	5
	United Kingdom	–	–	2	. . .
	Total	676	54	26	6

Source: Statistics Canada.
p Preliminary; – Nil; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified.

Gold 1989

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Gold prices declined during the first ten months of 1989, continuing a downward trend that began late in 1987. After trading at an average of US$404/oz. in January 1989, prices dropped to a low of $361 in September and then surged to over $400 in the last two months of the year. The downward trend was primarily attributable to the lack of negative developments on the political and economic fronts, the absence of accelerating inflation in developed economies and the strong expansion of gold production from existing and new mines facilitated by gold loans and forward sales transactions. The November surge in prices reflected fears of another strong correction on world stock markets and uncertainties about the fast pace of political and economic reforms occurring in the Eastern European countries, and also that gold had become an attractive investment, particularly in strong currency areas. The 1989 average price was $381, compared with $437 in 1988 and $447 in 1987.

There were 70 primary gold mines in Canada at the end of 1989, which accounted for about 80% of the total 158.4 t of gold produced during the year. Production in 1988 was 134.8 t.

CANADIAN DEVELOPMENTS

The year 1989 was one of growth for gold production. Expansions at existing mines and the opening of twelve new mines more than offsetting the seven mine closures caused by high operating costs and depressed gold prices. Canadian production increased every year during the 1980s, from 50.6 t in 1980 to 158.4 t in 1989. Canada's share of western world mine production also increased, from 5.3% in 1980 to 8.3% in 1988.

Reported value of production declined marginally in 1989, to $2332 million, despite higher production volume. However, actual revenues to producers were probably above the reported value due to the increasing practice of forward sales when prices are considered more favourable.

Canadian operating gold mines are shown on the attached map. Operating information for these mines may be found in the table "Principal Canadian Nonferrous and Precious Metals Mines" which follows the final commodity chapter of the Yearbook.

British Columbia

Production at the Lawyers mine in north-central British Columbia, operated by Cheni Gold Mines Inc., was expected to reach 1240 kg gold in 1989. The 550 t/d operation officially opened in August. Notwithstanding its isolated location, a two-month strike, capital cost overruns and lower gold prices, the company was profitable and anticipates increasing production to 1710 kg in 1990. The company plans to spend $1 million in exploration on the Cliff Creek zone in 1990.

The Golden Bear mine near Telegraph Creek in northwestern British Columbia, which was scheduled for operation in late 1988, was delayed until November 1989 because of environmental, native and construction considerations. As a result, capital costs almost doubled to $70 million. The joint venture between Chevron Canada Resources Limited and Homestake Mining Company plans to produce about 1860 kg/y of gold and 1026 kg/y of silver, on average, from the underground and open-pit reserves. Proven reserves provide for five years of operation at a head grade of 16.9 g/t of gold.

Westmin Resources Limited opened the Premier gold mine in late May, several months behind schedule due to equipment and operational difficulties. The open-pit mine has proven and probable reserves of 8.2 Mt with an average grade of 2.2 g/t gold and 65.3 g/t silver. Targeted annual production is 2395 kg of gold and 27 682 kg of silver during the first four years.

Continental Gold Corp. and BP Resources Canada Limited are further developing the Mt. Milligan gold-copper project near Mackenzie, British Columbia. Mineral reserves are reported to total more than 272 Mt in two deposits, averaging about 0.3% copper and 0.9 g/t gold. Engineering, environmental and socio-economic studies are under way for a 1.55 Mt/y open-pit mine with an annual production of 12 441 kg of gold and 50 000 t of copper. Rio Algom Limited acquired an 8% equity interest in Continental Gold Corp. in purchasing the shares previously held by Homestake Mining.

In the Iskut River gold camp, Skyline Gold Corporation is working to improve operations at its recently opened Johnny Mountain mine. The cyanide circuit was removed and a new three-stage cleaning system was installed and, as a result, gold recovery improved from 61% to 84%. Reserves were increased through an exploration program over the summer and consideration was being given to a re-grind circuit to further improve the recovery rate. Mine viability would also be improved by construction of an access road to the Iskut River camp. At the time of writing, no decision had been made on the road.

Control of the Cinola project in the Queen Charlotte Islands was acquired by Barrack Mines Limited of Australia through its purchase of a 54% interest in City Resources (Canada) Limited. It is expected that this will strengthen the financial and technical capacity of City Resources to bring the large open-pit project into production. Mineral reserves stand at 27.3 Mt with 2.24 g/t of gold. A feasibility study was completed and capital costs were estimated at $119 million.

On the exploration side, Bond International Gold, Inc. has made a gold discovery at its Red Mountain project near Stewart. Calpine Resources Incorporated released promising additional drilling results on the Eskay Creek project in northwestern British Columbia. At year-end, Prime Resources Corporation and Calpine Resources proposed to merge. Prime Resources had a 34% equity interest in Calpine before the proposed merger. Newhawk Gold Mines Ltd. (60%) and Granduc Mines Limited (40%) invested $10 million in an exploration program on the Sulphurets project near Stewart, British Columbia. Promising grades have been identified.

Yukon and Northwest Territories

Neptune Resources Corp. completed a financial package to proceed with the Colomac open-pit gold mine 220 km north of Yellowknife. Neptune is building a carbon-in-pulp mill with a designed capacity of 10 000 t/d, which is believed to be the largest gold processing plant in Canada. Construction on the $155 million project began in March and its start-up is expected in April 1990. Production at a rate of 6224 kg/y of gold is forecast at an estimated average cost of US$250/oz. over the life of the mine. Proven and probable reserves stand at 16 Mt at an average grade of 1.99 g/t.

B.Y.G. Natural Resources Inc. spent $5.3 million to develop the Brown McDade gold-silver mine in the Yukon for production at 300 t/d by the end of 1989.

Saskatchewan

The Jolu mine in the La Ronge district, operated by International Mahogany Corp. (70%) and Corona Corporation (30%), opened in late 1988, ahead of schedule and at a modest capital cost of $18.3 million. The mine turned out to be better than expected with higher mill feed grade and a higher recovery rate. Proven and probable reserves stand at 627 000 t grading 11.8 g/t. The mine is expected to produce 1555 kg/y at a direct operating cost of about US$185/oz.

Milling at the small Star Lake mine, operated by Cameco - A Canadian Mining & Energy Corporation, ceased in April as ore reserves had been exhausted at the end of 1988. A mining consortium involving Cameco announced a promising gold discovery at the Preview Lake project. The joint venturers are proceeding with a feasibility study to determine the viability of a mine and a mill at the site.

Cameco (67%) and Trimin Resources Inc. (33%) are proceeding with a mine feasibility study on the Hanson Lake zinc-copper deposit in east-central Saskatchewan. The companies have defined an inferred reserve of 7.7 Mt grading 6.5% zinc, 1.1% copper, 31.1 g/t silver and 0.6 g/t gold.

Manitoba

Manitoba gold production was adversely affected by lower gold prices in 1989 with the closure of three mines: Puffy Lake, McLellan and Tartan Lake. However, the depressed gold price was not the only contributing factor in those mine closures.

In October, Granges Inc. announced the indefinite suspension of operation at the Tartan Lake mine only two years after it began operation in September 1987. The announcement followed new managerial direction consequent to the acquisition of a 33% equity interest in Granges by M.I.M. Holdings Limited of Australia. While weak gold prices were a contributing factor in the shut-down decision, the mine has been plagued with production and development problems and never lived up to expectations. Total gold production for the year was estimated at about 544 kg. Operating costs were US$393/oz. excluding capital costs for development and ore definition drilling.

LynnGold Resources Inc. was also forced to cease operations at the McLellan mine because of weak gold prices and high operating costs. Although operating costs had been curtailed significantly, the mine was still unable to operate at a profit. Last-minute negotiations between the company and the province to keep the mine open did not succeed. The mine employed 250 workers.

In June, Pioneer Metals Corporation closed the Puffy Lake mine leaving 150 employees without work. The mine poured its first doré bar in December 1987 but, because of lower-than-expected ore grades and consequent dilution problems, the operation was uneconomical.

Ontario

In August, the Supreme Court of Canada ruled that the Page-Williams gold mine belonged to a joint venture between Corona Corporation and Teck Corporation, thus confirming the 1986 Supreme Court of Ontario's decision. The ruling ended an eight-year legal battle between Corona and LAC Minerals Ltd. LAC Minerals was also ordered to transfer to Corona $80 million of profits from the mine which had been kept in trust since the 1986 ruling. In return, Corona had to pay LAC Minerals $210 million for having developed the mine. The mine has proven and probable reserves of 37.5 Mt grading 5.6 g/t gold. Gold production in 1989 was an estimated 15 552 kg, up from 11 819 kg in 1988. The mine now operates at about its maximum rated capacity of 6000 t/d. Further exploration is planned to seek additional reserves. The facility was renamed the Williams mine by Corona.

Shortly after the Supreme Court's ruling, LAC Minerals acquired a 65% equity interest in Bond International Gold, Inc. from Australian entrepreneur Alan Bond, at a cost of US$373 million. The transaction more than doubled gold output controlled by LAC and significantly improved its reserves. Bond International has gold mines in the United States, Chile, Canada (Golden Patricia) and Australia.

Flanagan McAdam Resources Inc. (50%) and Windarra Minerals Ltd. (25%) opened the Magnacon mine in the Mishibishu area in June, four months behind schedule. With 1.4 Mt of reserves averaging 7.4 g/t gold, production is targeted at 600 t/d initially and to increase to 800 t/d in the future. The joint venturers expect to produce 2488 kg/y.

It took six years for St. Andrew Goldfields Ltd. to develop sufficient reserves to build a 500 t/d mill and to complete underground development work before beginning milling from the Stock Township gold mine. The company expects to produce an annual 933 kg/y gold from three zones. The company is also exploring for more reserves.

Placer Dome Inc. opened the Dona Lake mine in northwestern Ontario in the second quarter of 1989. Proven and probable reserves are reported at 754 000 t grading 7.4 g/t. Annual gold output is expected to be about 1280 kg.

Two years after buying the Kerr mine in Virginiatown from Kerr Addison Mines Limited, Golden Shield Resources Limited filed for voluntary bankruptcy. Golden Shield had effectively increased reserves during the period but milling results were less than anticipated, with disappointing head grades and a drop in the recovery rate. Deak Resources Corporation sought to acquire the Kerr mill to process gold and nonferrous ores from proposed mines in the Rouyn-Noranda area.

Another casualty of mining difficulties and company debt was the Surluga mine operated by Citadel Gold Mines Inc. near Wawa, which had to suspend underground production. The company was unable to achieve a commercial production rate. By year-end, a corporate restructuring plan was approved and it is anticipated that exploration will continue.

On the Musselwhite gold project, a $17 million underground exploration project was completed. A feasibility study is under way for a 2200 t/d underground mine at a cost of $100 million. Esso Minerals Canada sold its 24% stake in three equal portions to the other partners. Placer Dome Inc. now holds 43%, Inco Limited holds 32% and Corona Corporation holds 25% of the project.

Environmental concerns have been expressed about the possible development of the Duport deposit on Shoal Lake, Ontario, which is connected to Winnipeg's water sources. Consolidated Professor Mines Limited has submitted an environmental application to develop the new mine at an estimated cost of $53 million. Proven and probable reserves are 2.2 Mt grading 12 g/t.

Inco Gold Company has dewatered the Cochenour shaft and drilled a zone that had not been previously mined. The Cochenour-Willans mine near Red Lake ceased production in 1971 after a 32-year life. Inco will complete its drilling and bulk sampling programs before proceeding with a feasibility study in 1990.

Quebec

The Joe Mann mine, which had been opened and closed twice before being re-opened by Campbell Resources Inc. in 1987, is proceeding to triple gold production by 1992. In July, the company began work on a new shaft plus development work to access new ore reserves. Additional production of 500 t/d from October 1990, increasing to 1800 t/d in March 1991, is expected. The mill was also refurbished to increase recovery and reduce ore transportation costs to Campbell's flotation mill at Chibougamau. By 1992, Campbell forecasts production at 3110 kg/y.

Inco Gold and Golden Knight Resources Inc. are developing a second mine on their Casa Berardi property. The Golden Pond West deposit is being developed for production by July 1990 at a production rate of 1244 kg/y. Diluted mineral reserves stand at 2 Mt grading 8.1 g/t.

Société Minière Sphinx Inc. announced that it will build a gold heap leach facility, the first in Quebec, at its Duvay-Obalski open-pit mine near Val-d'Or. The company began construction of a Merill-Crowe mill and expects to treat 400 000 t/y grading 3.1 g/t beginning in 1990.

Aur Resources Inc. brought the Kierens mine into commercial production during the summer. Proven and probable reserves stand at 360 420 t grading 6.8 g/t. The ore is shipped to the Dorval mill but the company is considering the construction of its own mill. The Kierens zone is expected to produce 746 kg gold during its first year. The company is also exploring the Norlartic property, which is accessible from the Kierens shaft. Considerable gold mineralization has been intersected.

Aur Resources released preliminary geological reserves information on the Louvicourt copper-zinc-gold discovery. It indicated a 32.7 Mt deposit averaging 3.11% copper, 1.34% zinc and about 30 g/t silver and 1.25 g/t gold. The Louvicourt property is being explored in a joint venture with Louvem Mines Inc. Noranda Inc. owns 17% of Louvem and sought an injunction to stop Aur Resources from proceeding with underground exploration of the property as a result of a legal dispute over ownership rights.

Augmitto Explorations Limited brought the Beauchastel property, near Rouyn-Noranda, into commercial production. Augmitto has re-erected the mothballed Langmuir mill at the property. A production rate of 1000 t/d is planned with an 1866 kg/y gold target. Proven and probable reserves stand at 1.9 Mt averaging 5.3 g/t.

Bachelor Lake Gold Mines Inc. closed the Bachelor Lake mine at Desmaraisville as production costs exceeded revenues. The mine had raised production rates in July 1987, following a production suspension to carry out development work.

Cambior inc. brought two mines into commercial production in 1989. The Pierre Beauchemin mine, near Rouyn-Noranda, began production in January and indications are that mill grade and recovery are running on target. The ore is treated at the Vezina mill, the exhausted underground Vezina mine having closed at the end of 1988. Proven and probable reserves stand at 1.1 Mt averaging 4.8 g/t gold.

Cambior also opened the Lucien C. Beliveau mine, formerly the Pascalis project, near Val-d'Or in September when construction of a 1000 t/d mill was completed. Additional cyanidation processing is done at the Vezina mill. Proven and probable reserves stand at 1.3 Mt averaging 3.1 g/t. The Beliveau mill will also treat ores from the recently acquired Chimo mine. Cambior acquired a 50% interest in the Chimo mine from Louvem Mines Inc. and is managing the mining operation. Production was halted to concentrate on further development of the deposit, and the shaft expansion program was completed.

Cambior was also active on exploration. Underground exploration was completed at the joint venture Silidor project with Noranda Exploration Company, Limited as manager and Nova-Cogesco Resources Inc., near Rouyn-Noranda. Production is expected to begin in 1990. Diluted mineral reserves are estimated at 4.5 Mt grading 5.6 g/t. Ore would be treated at the Vezina mill. A shaft-sinking project on the Mouska project was completed in June. Further development work was also carried out.

Goldex Mines Limited postponed a production decision on the Dubuisson Township property near Val-d'Or because of low gold prices.

Atlantic Canada

NovaGold Resources Incorporated began commercial production in September at the Murray Brook mine near Bathurst. The mine hosts proven reserves of 1.69 Mt grading 1.15 g/t gold and 46.3 g/t silver. Initial results revealed an average head grade of 1.15 g/t and a 79.6% recovery rate. The company expects to produce 373 kg/y of gold and 3110 kg/y of silver during the mine's five-year operating life.

Coxheath Gold Holdings Limited had hoped to produce 933 kg of gold in 1989 from its Tangier mine on Nova Scotia's eastern shore. However, by year-end, commercial production had not been achieved because of the coarse nature of the gold mineralization. Proven and probable reserves stand at about 500 000 t averaging 9.5 g/t.

Seabright Explorations Incorporated has obtained encouraging mill test results from its Touquoy open-pit gold property at Moose River, Nova Scotia.

While gold production at the Hope Brook mine of BP Resources Canada Limited in Newfoundland increased significantly in 1989 compared with 1988, it was still below designed capacity and the mine was not profitable. In February and March, the 3000 t/d mill was temporarily suspended to modify effluent treatment facilities. Development of the underground mine was also completed in 1989.

WORLD DEVELOPMENTS

South Africa

South Africa is still the world's largest gold producer, with output of 619 t in 1988 and an estimated 612 t in 1989. However, its share of western world production fell from 70% in 1980 to 44% in 1988 and further in 1989 due to increased production elsewhere. Similarly, South Africa has moved from being the lowest cost gold producer in 1985 to the highest cost among the major producers. Gold accounts for some 45% of South Africa's export earnings and a balance of payments surplus is needed to repay its estimated US$22 billion foreign debt.

While South Africa's reserves are still the largest, future mine production faces major difficulties because ore grades are falling, gold reserves are deep, and domestic inflation and, consequently, the costs of labour, are rising rapidly. It is against that background and declining gold prices that South Africa's Chamber of Mines celebrated its centenary in October. Throughout its history, the Chamber of Mines has assumed responsibility for overall policy coordination, research, recruitment of labour and, until recently, marketing of the Krugerrand and promotion through its former subsidiary, the International Gold Corporation.

It is also against that background and threats of mine closures that wage negotiations have been carried out. A national strike was averted in 1989 with wage increases ranging from 13-21.5% for the black miners and of 13.5% for white miners. The National Union of Mineworkers, representing 240 000 black workers, had originally demanded wage increases of up to 96%. The inflation rate is about 14% in South Africa.

In an effort to improve productivity to counteract sagging prices and increasing labour costs, General Mining Union Corporation Limited (Gencor), South Africa's second biggest mining house, announced plans to lay off 13 400 miners at four of its mines: West Rand Consolidated Mines Limited, Bracken Mines Ltd., Grootvlei Proprietary Mines Ltd. and Leslie Gold Mines Ltd.

In June, Rand Mines Limited announced a rescue package to continue operation at East Rand Proprietary Mines, Limited and to cut 10 000 jobs at two other mines, Durban Roodepoort Deep, Ltd. and Harmony Gold Mining Company Limited. Details on government participation in the rescue package are not known but the company requested the re-introduction of the negative taxation program, the State Assistance Scheme, which was implemented during the 1970s.

In May, a hostile bid to acquire Consolidated Gold Fields PLC by Minerals and Resources Corporation Limited (Minorco) lapsed following a legal saga in which the U.S. Court of Appeals granted an injunction blocking the bid on the grounds that the acquisition would result in Minorco dominating the gold market. Minorco is 39.1% owned by Anglo American Corporation of South Africa Ltd. and 21% by De Beers Consolidated Mines, Limited, both of which are linked to the Oppenheimer family of South Africa. Shortly thereafter, Consolidated Gold Fields accepted a cash offer for all ordinary shares from Hanson PLC, an industrial empire ranging from building materials to chemicals. One month later, Hanson sold a 30% stake in Gold Fields of South Africa Ltd. to a joint company owned by Gold Fields of South Africa and Driefontein Consolidated Limited.

United States

U.S. gold production almost quadrupled from 66 t in 1984 to an estimated 240 t in 1989, with nearly half of the increase coming from Nevada. Growth in Nevada was made possible by the application of a new, low-cost method of treating low-grade ores, the heap leach process. This technique, combined with financing by gold loans and forward sales, considerably shortened the time between discovery of low-grade gold reserves and the beginning of commercial production.

Newmont Mining Corporation is the largest U.S. gold producer with 28.9 t from five mines in 1988. With its current US$400 million expansion program, production is expected to reach 49.7 t by 1991.

American Barrick Resources Corporation announced a US$65 million program to expand production at the Nevada Goldstrike mine from 3700 kg in 1988 to 28 500 kg by 1992.

Amax Gold Inc., a subsidiary of AMAX Inc., increased its gold production from zero in 1985 to about 7776 kg in 1988 with its main asset, the Sleeper Gold Mine in Nevada, as America's lowest-cost producer. Amax Gold is developing the Wind Mountain deposit where it expects to produce 1244 kg/y.

Australia

Australian gold production showed a spectacular increase similar to that in the United States, rising from 39.1 t in 1985 to an estimated 202 t in 1989. In 1988, Australia displaced Canada as the western world's third largest gold producer. A contributing factor in the large production increase stems from the government's decision to end the tax-exempt status of income generated from gold mine operations by 1991. A report issued by the Bureau of Mineral Resources, Geology & Geophysics (BMR) estimated that Australian gold production will reach 220 t in 1990 and decline thereafter to 175 t by 1993.

Placer Dome Inc. announced that gold output from the newly opened Big Bell mine in Western Australia has been below expectations due to dilution difficulties.

Homestake Gold of Australia Ltd. and Bond International Gold, Inc. merged their Kalgoorlie gold interests into a new company, Kalgoorlie Consolidated Gold Mines Pty Ltd., to operate the Kalgoorlie mine jointly as the largest open-pit gold mine in Western Australia. The joint venturers expect to produce 24.8 t/y.

Placer Pacific Pty Ltd., a subsidiary of Placer Dome Inc., and Delta Gold NL expect to produce 7.3 t/y of gold from the Granny Smith project planned for start-up in February 1990.

Western Mining Corporation Holdings Limited expects to produce 31 t/y of gold by 1990 from its 18 operations in five countries. In Australia, Western is expanding the Kambalda, Hill 50 and Hedges mines. Other major Australian expansions are occurring at the Boddington and Telfer mines.

Papua New Guinea

Gold production in Papua New Guinea (PNG) has been stable during the last four years but significant projects under way could double PNG production by 1992. Placer Dome Inc. officially opened the Misima mine, which is expected to produce 12.4 t in its first 12 months of operation and about 6.5 t/y thereafter. Due to modifications to the ore delivery system, the forecast production for the first six months was revised downward to 4.9 t.

Placer Dome Inc., through its PNG subsidiary, will manage the US$1 billion plus Porgera project in Enga province. Following agreements to build nine neutralizing ponds to treat waste and to provide training, employment and business opportunities to local people, the planned 39 months of construction began. Gold production is expected to begin in the second half of 1990 and to reach full production in the first half of 1991. Placer Dome has a 30% interest in the project and other partners are Renison Goldfields Consolidated Ltd. (30%) and M.I.M. Holdings Limited (30%). The PNG government is expected to take up an option for 10% equity.

U.S.S.R.

The U.S.S.R. is the world's second largest gold producer, with production estimated by The Gold Institute at 295 t in 1989, and it markets a large share of its production in the west. Crude oil, natural gas and gold export earnings are keys in the U.S.S.R.'s commercial policy and balance of payments. With the current fast pace of political reform and slow progress on economic improvements, it is anticipated by many that U.S.S.R. gold production and exports will be increased in order to earn additional foreign exchange. It is also thought that the U.S.S.R.'s gold reserves could play an important stabilizing factor in maintaining the external value of the rouble should it become a convertible currency.

China

The Beijing daily newspaper reported that Chinese officials had re-introduced a state monopoly on gold exploration by revoking the licences of some 300 000 prospectors. The new direction was implemented to reduce gold smuggling and environmental damage. Similarly, it was reported that China raised the price at which state banks buy gold from miners. While the banks paid international prices at the state official exchange rate, prospectors were able to get twice the official exchange rate on the black market.

China's gold export policy remained unchanged as it needs additional foreign currencies to offset payments on imports and repayment of foreign debt. China's external debt exceeded US$40 billion at the end of 1988 and repayment requirements are expected to reach an annual US$10 billion by 1992. China's annual gold production is a state secret, but production at 80 t for 1988 has been estimated by The Gold Institute. The New China News Agency reported China's official gold reserves at 394 t.

Brazil

Brazil's gold production hit the 100 t mark in 1988 and was still rising in 1989. About 80% of its production comes from the panning efforts of wildcat miners called "garimpieros." With an inflation rate in excess of 900% in 1988, domestic demand for gold was particularly strong and, conversely, gold exports declined. In 1989, inflation remained a problem which sustained strong domestic gold demand. Brazil is the sixth largest gold producer. The Central Bank does not release gold reserve figures but it is speculated that Brazil's reserves totalled 130 t at the end of 1989.

Chile

Chile's gold production is expected to rise from 20.6 t in 1988 and 27.3 t in 1989 to 43 t in 1992, according to figures released by the Chilean Copper Commission. Placer Dome Inc. and Consolidated TVX Mining Corporation announced that they will proceed with the second stage development of the La Coipa gold/silver mine with construction of a 16 500 t/d plant. Peak production is targeted at 6.2 t/y gold and 497 t/y silver. Mineral reserves are estimated at 72.3 Mt at an average grade of 1.1 g/t gold and 77.7 g/t silver.

Japan

Japan's gold imports have been substantial and rising in recent years with imports of about 254 t in 1987 and 317 t in 1988. In 1989, two separate events influenced Japanese interest in gold purchases. First, Japan introduced a 3% consumption tax on April 1 which replaced a 15% luxury tax on jewellery and precious metals products, excluding bars worth over 37 500 yen. The tax had the effect of raising the price of gold bars by 3% and cutting that of coins and jewellery by more than 10%. Preliminary import figures, excluding coins, indicated that imports for bars and jewellery were at 231 t during the first 10 months of 1989, essentially the same volume as the corresponding period in 1988. It is expected that the composition of the import figures will show bar imports down and gold for jewellery up because of the tax.

The second development relates to changes in regulations affecting the non-life insurance industry in Japan. These institutions are now permitted to hold up to 3% of their assets in gold. The above changes were often referred to as contributing factors in the gold price rally near year-end.

Taiwan

Taiwan overtook Japan as the world's largest importer of gold in 1988 with imports of 351 t, of which 200 t was bought by the Central Bank. In 1989, only 1.5 t was purchased by the Central Bank, which had gold reserves of 420.5 t at year-end. Total imports for 1989 were reported to be about 150-160 t, but 200-220 t would better reflect real imports if smuggled gold is taken into account. Although the 0.6% tax on imports of gold was eliminated in July, it was widely expected that gold smuggling would continue in order to evade income tax and handling charges.

Turkey

On April 1, gold trading was liberalized in Turkey when the Central Bank agreed to transfer gold imports at cost plus transport and insurance through a network of 23 authorized dealers who are allowed to sell gold against the foreign exchange. The Central Bank-brokered gold market is aimed at stopping gold smuggling, which was estimated at up to 70 t/y. It was also expected that liberalization of the gold market was a first step towards convertibility of the lira. During the first seven months of operation, 80.3 t of gold was sold on the new market.

Belgium

The Belgium National Bank sold 127 t of gold, or about 10% of its holdings, between December 20, 1988 and March 22, 1989. The selling operations were aimed at bringing the composition of the Central Bank reserves into line with that of neighbouring countries.

CONSUMPTION AND USES

The industrial consumption of gold, sometimes referred to as fabrication demand, includes gold consumed in jewellery, electronics, dentistry and both fake and official coins, even though the latter type of coin is often used for investment purposes. Table 4 gives some historical perspective to world gold consumption in these uses.

In Canada, the largest use of gold is for official coins. The Royal Canadian Mint produces two official coins that contain gold, a numismatic gold coin containing one quarter ounce of gold with a face value of $100 and the Gold Maple Leaf bullion coin family. Prior to 1987, the numismatic coin contained half an ounce of gold.

The Gold Maple Leaf bullion coin, with its very high purity, is world-renowned. In 1988, Canada regained its position as the world's top user of gold for coinage, after losing the lead to the United States in 1986 and 1987 when the United States launched the Eagle coin. In 1989, Canada kept its leading position with about 34.2 t of gold consumed and about 25% of the world coin market.

The Maple Leaf coin plays an important role in the Canadian gold industry. Since its introduction in 1979, the program has consumed some 410 t of gold, or about 50% of total Canadian production during that period.

The domestic carat jewellery industry has two main components, smaller manufacturers producing jewellery pieces in Canada and larger sales companies importing stock jewellery pieces for direct sale. On average, Canadian gold consumption for jewellery is about 10 t/y.

Most other gold products used in Canada are imported either in end-use form or in semi-manufactured alloy form. Canadian consumption of gold in electronics, dentistry and other industrial uses totalled just above one tonne in 1988 and was not expected to show any dramatic change in 1989.

MARKETS, PRICES AND STOCKS

In the last 15 years, gold-trading practices have changed drastically with liberalized trading laws and development of electronic markets in major financial centres. The price of gold used to be controlled by Central Banks' interventions on terminal physical markets. Now, the physical market represents only a fraction of the gold equivalent traded on the gold futures and options contracts on the New York Commodity Exchange (COMEX), the London Gold Market and the Tokyo Gold Exchange. While the price of gold is linked to supply-demand conditions, daily fluctuations motivated by speculation, computerized program trading and arbitrage are other key factors.

Another recent innovation on the gold market is the gold loan transaction in which gold-holders lend their gold for a fee. These loan transactions are used primarily by gold producers who earn instant cash flow by selling the borrowed gold and repaying the loan out of future gold mine production. The market usually reacts negatively on news of large loan agreements as more gold is added to the market. As we are now entering a period of repayment of these loans, future gold loans and repayments of old loans should more or less offset each other and have minimal impacts on the market.

In the first half of 1989, gold prices continued on a bearish track begun two months after the stock market crash in October 1987 when the gold price reached US$500. Lack of negative economic or political events and growing supply, combined with significant forward sales from producers, all contributed to depress gold prices. In January, the gold price decline was linked to reported huge sales by Australian producers who realized windfall profits from the sharp and sudden fall of the Australian dollar. In March, prices continued to fall on news, in particular, of a 31 t loan agreement by American Barrick Resources Corporation to finance development of its Goldstrike mine.

In May, the price declined further because the strong U.S. dollar reduced fears of spiralling inflation and also improved gold producers' returns denominated in weaker currencies. In June, the unrest in China did not spark a price increase, leading some to question whether gold was still a safe haven during turmoil periods. However, the rapid price escalation in November, prompted by the mini stock market crash and political uncertainties in the Eastern European countries, confirmed the confidence placed in gold during uncertain times.

OUTLOOK

Canadian gold production is expected to continue growing with expansion at existing mines and the continued development of new mines. Canada's cost-competitive position is good and is not expected to deteriorate because of falling grades or spiralling domestic cost increases. Gold exploration is still active and there are many promising properties which should more than compensate for future mine closures due to ore exhaustion.

Production is also expected to grow in the United States, PNG, Brazil, China and the U.S.S.R., and to remain stable in South Africa. Australian production is expected to grow next year but to decline thereafter because income from gold operations will become taxable in 1991.

In recent years, gold loans have become a rule in financing new mine projects and mine expansions. This innovative source of financing will not disappear in the future, although it is becoming more costly because of the increased risk involved. As old loans have to be repaid from future mine production, and such repayment is likely to more or less offset new loans, the impact on the gold market should be neutral.

The expected world growth in new mine supply is unlikely to be reduced by existing depressed prices because the two largest producers, South Africa and the U.S.S.R., have balance-of-payments difficulties and both need to generate large surpluses. China and Brazil also fall into that category. However, the current depressed prices should reduce the incentive for both recycling and sales by Central Banks from their official reserves.

On the demand side, the jewellery market has performed very well in periods of general economic expansion. It is uncertain whether demand will continue to expand in a stable or a recession scenario, but gold jewellery demand does tend to be quite price responsive.

As an investment, gold has to compete with alternative investment schemes during good and bad economic times. With continued world debt problems, political tensions and fears of spiralling inflation, gold should perform well in the medium-to-longer term.

Note: Information contained in this review was current as of mid-January 1990.

TABLE 1. CANADA, GOLD PRODUCTION AND TRADE, 1988 AND 1989

	1988		1989p	
	(kilograms)		(kilograms)	
Production				
Newfoundland	x		x	
Prince Edward Island	-		-	
Nova Scotia	x		x	
New Brunswick	393		341	
Quebec	33 538		35 955	
Ontario	62 463		80 707	
Manitoba	4 469		4 187	
Saskatchewan	1 480		2 737	
Alberta	27		5	
British Columbia	13 067		14 537	
Yukon	5 052		5 551	
Northwest Territories	11 880		12 051	
Total	134 813		158 440	
Total Value ($ million)	2 331.989		2 297.747	
Mine output(kg)	135 889		159 135	
			(Jan.-Sept.)	
Exports	(kilograms)	($000)	(kilograms)	($000)
Gold in ores and concentrates	9 831	94 068	8 088	76 698
Gold powder				
United States	1	15	1 241	152
Belgium	20	300	30	225
West Germany	4	72	-	-
Total	25	387	1 271	377
Other unwrought forms				
United States	45 416	756 831	47 273	672 009
Hong Kong	23 827	400 356	33 311	483 373
Japan	31 550	554 928	13 855	205 204
Switzerland	14 881	261 215	8 405	127 628
United Kingdom	2 059	34 427	4 467	64 059
People's Republic of China	799	13 540	1 754	24 895
Other countries	4 472	75 677	1 920	24 541
Total	123 005	2 096 984	110 985	1 601 719
Other semi-manufactured forms				
Belgium	3 880	59 956	389	2 742
Jamaica	-	-	82	1
Other countries	25	333	14	160
Total	3 905	60 291	485	2 906

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989p	
	(kilograms)	($000)	(kilograms)	($000)
Imports				
Gold in ores and concentrates				
Gold powder	1 588	23 107	691	8 936
United States	30	254	7	88
Other countries	. . .	3	. . .	3
Total	30	257	7	92
Other unwrought forms				
United States	41 976	665 526	24 966	295 432
Uruguay	39	619	3 907	47 451
Mexico	4 085	69 664	3 281	47 006
Nicaragua	1 342	14 148	1 303	11 477
Other countries	3 102	50 547	354	5 048
Total	50 544	800 512	33 809	406 420
Other semi-manufactured forms				
United States	223	3 194	268	2 269
West Germany	626	3 416	167	1 827
Switzerland	91	1 106	73	789
Other countries	12	112	12	175
Total	951	7 831	520	5 064

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; - Nil; x Confidential; . . . Too small to be expressed.

TABLE 2. CANADA, GOLD PRODUCTION BY SOURCE, 1970, 1975, 1980 AND 1983–89

	Auriferrous Quartz Mines		Placer Operations		Base-Metal Ores		Total	
	(kg)	(%)	(kg)	(%)	(kg)	(%)	(kg)	(%)
1970	58 592	78.2	229	0.3	16 095	21.5	74 915	100.0
1975	37 530	73.0	335	0.6	13 569	26.4	51 433	100.0
1980	31 929	63.1	2 060	4.0	16 632	32.9	50 620	100.0
1983	55 522	75.5	3 235	4.4	14 756	20.1	73 512	100.0
1984	62 554	75.0	3 393	4.1	17 499	20.9	83 446	100.0
1985	67 241	76.8	3 464	4.0	16 857	19.2	87 562	100.0
1986	83 197	80.9	2 802	2.7	16 900	16.4	102 899	100.0
1987	94 723[r]	81.8[r]	4 009	3.5	17 086[r]	14.8[r]	115 818	100.0
1988	112 404	83.4	4 879	3.6	17 530	13.0	134 813	100.0
1989[p]	135 294	85.4	5 049	3.2	18 097	11.4	158 440	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[p] Preliminary; [r] Revised.

Note: Totals may not add due to rounding.

TABLE 3. CANADA, GOLD PRODUCTION, AVERAGE VALUE, AND PERCENT OF TOTAL MINERAL PRODUCTION

	Total Production	Total Value	Average Value[1]	Gold as a Percent of Total Mineral Production
	(kg)	($000)	($/g)	(%)
1970	74 915	88 057	1.18	1.5
1975	51 433	270 830	5.27	2.0
1980	50 620	1 165 416	23.02	3.7
1981	52 034	922 089	17.72	2.8
1982	64 735	968 012	14.95	2.9
1983	73 512	1 230 886	16.74	3.2
1984	83 446	1 252 283	15.01	2.9
1985	87 562	1 219 653	13.93	2.7
1986	102 899	1 689 292[r]	16.42[r]	5.2
1987	115 818	2 204 472	19.03	6.1
1988	134 813	2 331 989	17.30	6.3
1989[p]	158 440	2 297 747	14.50	5.9

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Value is based on average reported sales.

[p] Preliminary; [r] Revised.

TABLE 4. NON-SOCIALIST WORLD GOLD CONSUMPTION, 1980 AND 1986–88

Fabricated Gold	1980	1986	1987	1988
			(tonnes)	
Developed Countries				
Carat jewellery	315	565	561	644
Electronics	94	120	118	127
Dentistry	63	49	45	48
Other uses	58	51	51	53
Medals and fake coins	18	4	7	8
Official coins	170	301	170	86
Total	718	1 090	952	966
Developing Countries				
Carat jewellery	187	552	589	839
Electronics	2	4	6	7
Dentistry	2	2	3	3
Other uses	4	5	6	6
Medals and fake coins	3	8	8	8
Official coins	21	26	30	16
Total	219	597	642	879
Totals				
Carat jewellery	502	1 117	1 150	1 483
Electronics	96	124	124	134
Dentistry	65	51	48	51
Other uses	62	56	57	59
Medals and fake coins	21	12	15	16
Official coins	191	327	200	102
Total	937	1 686	1 594	1 845

Source: Consolidated Gold Fields PLC, "Gold 1989."

TABLE 5. GOLD MINE PRODUCTION IN THE NON-COMMUNIST WORLD, 1980 AND 1986-88

	1980	1986	1987	1988
			(tonnes)	
South Africa	675.1	640.0	607.0	621.0
Canada	50.6	102.9	114.4	128.5
United States	30.2	115.8	154.9	205.3
Other Africa				
Ghana	10.8	11.5	11.7	12.1
Zimbabwe	11.4	14.9	14.7	14.8
Zaire	3.0	8.0	12.0	12.5
Other	8.0	18.2	25.0	27.5
Total Other Africa	33.2	52.6	63.4	66.9
Latin America				
Brazil	35.0	67.4	83.8	100.2
Bolivia	2.0	6.0	6.0	9.0
Colombia	17.0	27.1	32.5	33.4
Dominican Republic	11.5	9.1	7.9	7.8
Chile	6.5	18.9	19.2	22.7
Peru	5.0	10.9	10.8	10.0
Mexico	5.9	8.3	8.3	10.7
Venezuela	1.0	15.0	16.0	16.0
Other	4.8	13.0	15.1	16.1
Total Latin America	88.7	175.7	201.1	225.9
Asia				
Philippines	22.0	38.7	39.5	42.7
Japan	6.7	14.0	13.6	14.4
India	2.6	2.1	1.6	1.8
Other	4.5	14.9	18.7	20.4
Total Asia	35.8	69.7	73.4	79.3
Europe	11.8	15.3	16.9	18.6
Oceania				
Papua New Guinea	14.3	36.1	33.9	22.6
Australia	17.0	75.1	108.0	152.0
Other	1.0	4.0	4.5	6.2
Total Oceania	32.3	115.2	146.4	190.8
Total	957.7	1 292.5	1 382.3	1 538.0

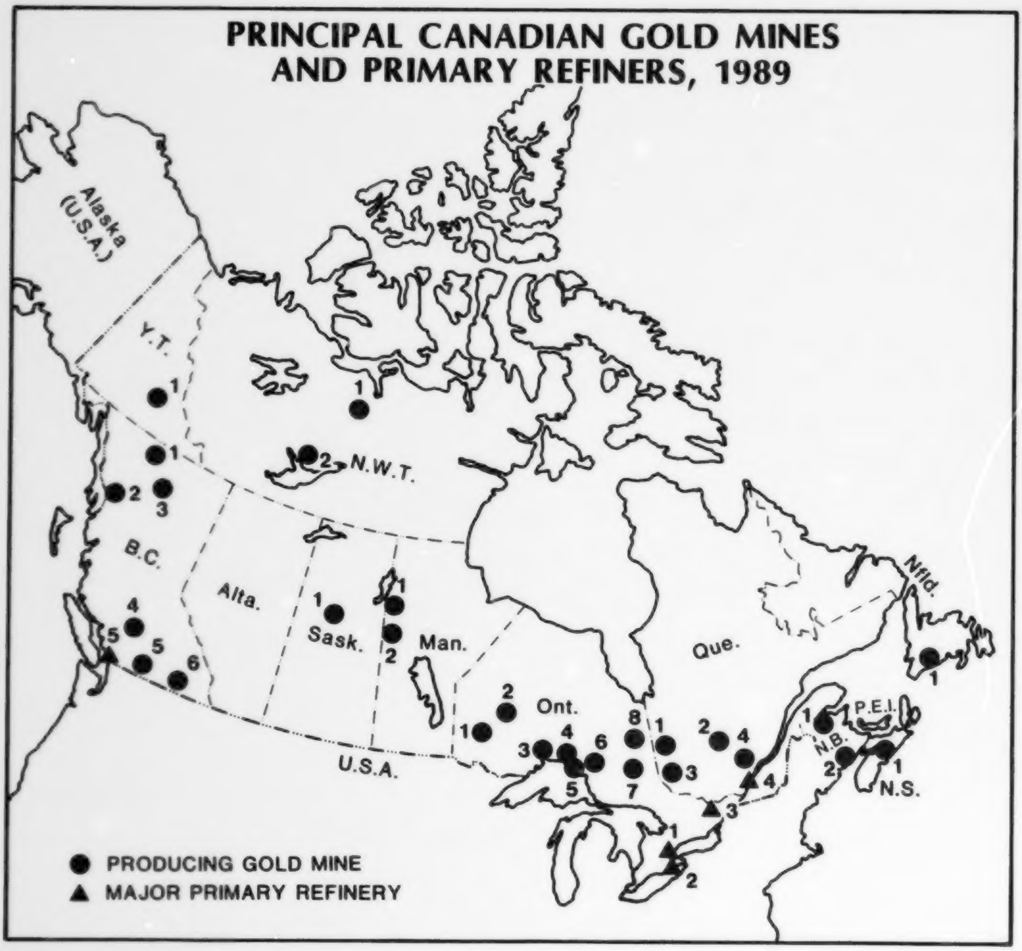
Source: Consolidated Gold Fields PLC, "Gold 1989."

TABLE 6. AVERAGE ANNUAL GOLD PRICES 1970-79 (MONTHLY 1988 AND 1989)

Year	US$/oz.	C$/oz.	Year	US$/oz.	C$/oz.
1970	35.97	37.54	1980	614.38	719.08
1971	40.87	41.27	1981	459.22	550.57
1972	58.22	57.66	1982	375.52	463.51
1973	97.22	97.24	1983	423.52	521.82
1974	158.80	155.36	1984	360.63	466.99
1975	160.96	163.76	1985	317.35	433.21
1976	124.78	123.01	1986	367.58	510.73
1977	147.80	157.10	1987	446.66	592.18
1978	193.51	220.74	1988	436.45	554.76
1979	305.69	358.12	1989	381.27	451.33

Month	1988		1989	
	(US$/oz.)	(C$/oz.)	(US$/oz.)	(C$/oz.)
January	477.71	614.34	404.45	481.70
February	442.12	561.00	387.97	461.21
March	443.49	554.02	390.28	466.31
April	451.56	557.21	384.72	457.23
May	451.32	558.01	371.35	442.65
June	451.66	550.00	367.73	440.64
July	437.46	528.40	375.21	446.15
August	431.29	527.06	365.53	429.54
September	414.81	509.34	361.80	427.70
October	406.39	489.92	366.80	430.78
November	420.00	511.45	394.36	461.21
December	422.14	504.88	409.71	475.94

Source: London Gold Market. Compiled by Energy, Mines and Resources Canada.



PRINCIPAL CANADIAN GOLD MINES AND PRIMARY REFINERS, 1989

Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.A.
● PRODUCING GOLD MINE
▲ MAJOR PRIMARY REFINERY

MAJOR PRIMARY GOLD MINES IN CANADA, 1989

Yukon Territory:

1. Canamax Resources Inc. - Ketza River mine

Northwest Territories:

1. Echo Bay Mines Ltd. - Lupin mine
2. Giant Yellowknife Mines Limited - Giant mine
   NERCO Minerals Company - Con mine
   Treminco Resources Ltd. - Ptarmingan and Tom mines

British Columbia:

1. International Taurus Resources Inc. - Taurus Mine
   Chevron Canada Limited/Homeslake Mining
   Company - Golden Bear mine
2. Skyline Gold Corporation - Johnny Mountain mine
   Westmin Resources Limited - Premier mine
3. Cheni Gold Mines Inc. - Lawyers mine
4. Blackdome Mining Corporation - Blackdome mine
5. Corona Corporation - Nickel Plate mine
6. Skylark Resources Ltd. - Dankoe mine

Saskatchewan:

1. La Range Area
   Cameco - A Canadian Mining & Energy Corporation - Star Lake mine
   Corona Corporation - Jolu Mine

Manitoba:

1. LynnGold Resources Inc. - MacLellan mine
2. Granges Inc. - Tartan Lake mine
   Pioneer Metals Corporation - Puffy Lake mine

Ontario:

1. Red Lake Area
   - Placer Dome Inc. - Campbell and Dona Lake mines
   - Dickenson Mines Limited - Arthur W. White mine
2. Pickle Lake Area
   - Bond Gold Canada Inc. - Golden Patricia mine
3. Ateba Mines Inc.
4. Hemlo Area
   - Corona Corporation/Teck Corporation - Williams mine
   - Hemlo Gold Mines Inc. - Golden Giant mine
   - Teck-Corona Operating Corporation - David Bell mine
5. Flanagan McAdam Resources Inc.
6. Wawa Area
   - Corona Corporation - Renabie mine
   - Canamax Resources Inc. - Kremzar mine
   - Muscocho Explorations Ltd. - Magino mine

7. Timmins - Kirkland Lake Area
    Placer Dome Inc. - Dome Mine
    Giant Yellowknife Mines Limited - Pamour #1, Timmins and Ross mines
    Falconbridge Gold Corporation - Owl Creek and Hoyle Pond mines
    LAC Minerals Ltd. - Macassa and Lake Shore mines, Lake Shore tailings project
    American Barrick Resources Corporation - Holt-McDermott mine
    Canamax Resources Inc. - Bell Creek mine
    ERG Resources Inc. - Timmins Tailings project
    Eastmaque Gold Mines Ltd. - Kirkland Lake Tailings project
    Golden Shield Resources Ltd. - Kerr mine
    Queenston Mining Inc. - McBean mine
    St. Andrew Goldfields Ltd.
8. Placer Dome Inc. - Detour Lake mine

Quebec:

1. Northwestern Area
    Agnico-Eagle Mines Limited - Agnico-Eagle and Telbel mines
    Inco Gold Company - Golden Pond East mine
2. Desmaraisville - Chibougamau Area
    Minnova Inc. - Lac Shortt mine
    Bachelor Lake Gold Mines Inc. - Bachelor Lake mine
    Campbell Resources Inc. - Joe Mann, Cedar Bay and S-3 mines
3. Noranda Rouyn - Val-d'Or Area
    Rouyn Mining Resources Inc. - Francoeur mine
    LAC Minerals Ltd. - Doyon and Bousquet mines
    Dumagami Mines Inc. - Donald LaRonde mine
    Augmitto Explorations Ltd. - Beauchastel mine
    American Barrick Resources Corporation - Camflo Malartic Hygrade mine
    Malartic Hygrade Gold Mines (Canada) Ltd. - Orion mine
    Placer Dome Inc. - Sigma and Kiena mines
    Belmoral Mines Ltd. - Ferderber and Dumont mines
    Aurizon Mines Ltd. - Beacon mine
    Aur Resources Inc. - Kierens mine
    Cambior inc. - Pierre Beauchemin and Lucien C. Beliveau mines
    Aurizon Mines Ltd. - Sleeping Giant mine
    Louvem Mines Inc. - Chimo mine
4. Muscocho Explorations Ltd. - Montauban mine

New Brunswick:

1. NevaGold Resources Incorporated - Murray Brook mine
2. Gordex Minerals Limited - Cape Spencer mine

Nova Scotia:

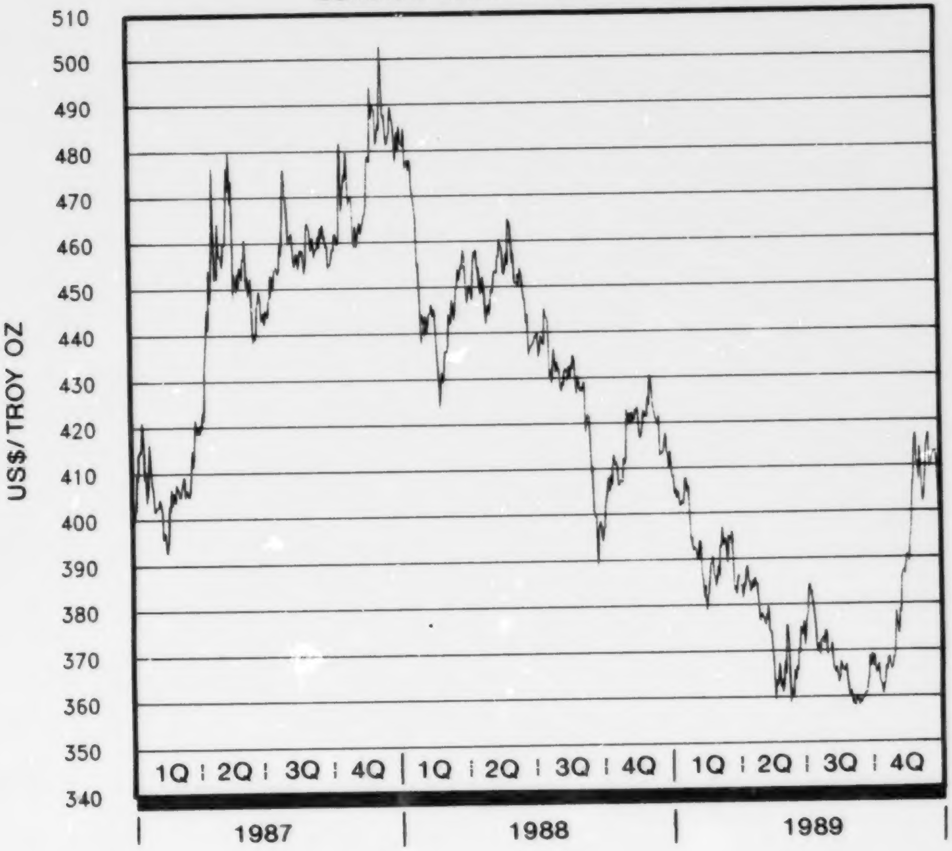
1. Westminer Canada Limited - Beaver Dam and Forest Hill mines
    Coxheath Gold Holdings Limited - Tangiers mine

Newfoundland:

1. Hope Brook Gold Inc. - Hope Brook mine

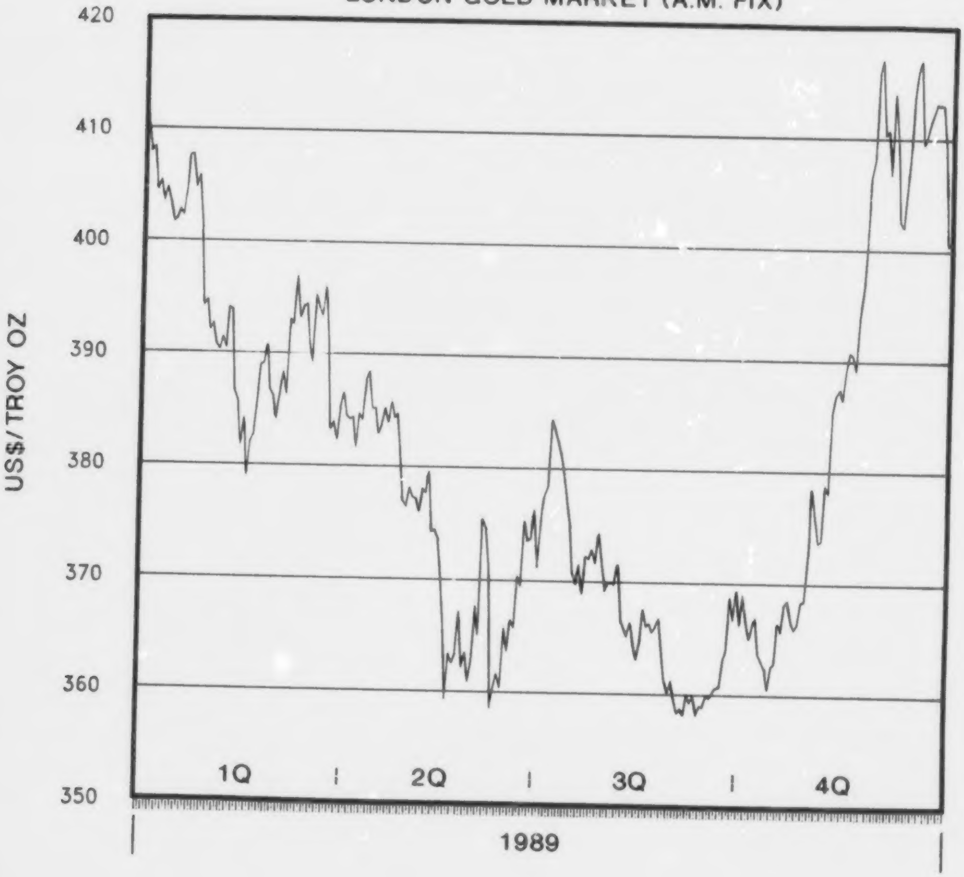
DAILY GOLD PRICES 1987–89

LONDON GOLD MARKET (A.M. FIX)



DAILY GOLD PRICES 1989

LONDON GOLD MARKET (A.M. FIX)



Graphite

1989

M.A. Boucher

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SUMMARY

Asbury Graphite Quebec Inc. remained Canada's only producer of natural graphite in 1989.

Consumption of graphite in Canada in 1988, the latest year for which statistics were available, was 15 644 t, compared with 14 403 t in 1987. About 35% of graphite consumption is natural graphite, of which 90% is flake. Most graphite is used as foundry facing, and in the metallurgical and refractory industries.

Imports of crude graphite for the first nine months of 1989 were valued at $1.57 million. Imports for twelve months in 1988 were $3.07 million. Nearly all graphite produced in Canada is exported to its parent company in the United States.

During 1989, exploration and development of graphite deposits were very active, especially in Ontario and Quebec. Efforts were made by several companies in Canada to produce very high-purity graphite for specialty applications, and exfoliated graphite for the manufacture of graphite foil in uses such as gasketing material and pipe-joint packing.

World demand for natural graphite continued to be strong in 1989.

NATURAL GRAPHITE

Graphite is a natural form of carbon. Natural graphite is a lustrous, black carbon mineral, crystallized in the hexagonal system with rhombohedral symmetry. Flake graphite is opaque, flexible and sectile, and exhibits perfect basal cleavage. Natural graphite is unctuous and is relatively soft with a hardness of 1 to 2 on the Mohs scale. It has a black colour and a black streak on glazed porcelain. Its specific gravity is 2.266 g/cm^3. Graphite is an excellent conductor of heat and electricity, and it has a high melting temperature of 300°C. It is extremely resistant to acid, chemically inert and highly refractory.

Natural graphite is widely distributed throughout the world and is of common occurrence in metamorphic rocks produced by regional or contact metamorphism. Commercially, natural graphite is classified as amorphous, crystalline lump (or vein) and flake. Amorphous graphite is a microcrystalline graphite formed by crystallization of the carbon from organic sediments. The graphite occurs as distorted seams of minute microcrystalline particles intermixed with ungraphitized materials. The graphite content may vary from 15% to 98%, depending on the degree of metamorphism and the original carbon content in the sediments. Crystalline lump occurs in the form of massive vein or circular accumulation formed probably from hydrothermal origin. Deposits are found in fissures or other cavities in igneous or metamorphic rocks. The size of the particles varies from fine grains to large lumps. The vein deposits vary widely in width from 2 mm to more than 2 m. Flake graphite is found disseminated in metamorphosed siliceous or calcareous sediments such as marble, gneiss and schist.

Flake is defined as thin flakes which are classified from coarse to fine and which are graded according to their graphitic carbon content.

OCCURRENCES

Graphite deposits of potentially commercial interest in Canada occur principally in rocks of the Grenville series of eastern Canada. The mineral is found in disseminated crystalline flake and vein forms. Most Canadian graphite deposits are associated with graphite gneiss and crystalline limestones which have been subjected to contact metamorphism associated with tectonic features such as folding, compression and fracturing, and with pegmatitic intrusions. The richest ore zones occur as a succession of veins or lenticular bodies that gradually merge into the adjacent non-graphititic host rock and that are bordered by lenses of lower-grade ore.

Flake graphite deposits have been reported mainly in Quebec and Ontario, but also in New Brunswick, Nova Scotia, and Saskatchewan.

In Quebec, graphite deposits are located mainly along the Grenville series in several townships of western Quebec: Buckingham, Argenteuil and Pontiac. The disseminated flake graphite variety is dominant, in biotite gneiss and crystalline limestone associated with biotite quartzite, but the vein variety is also reported along the contact of intrusive rocks and crystalline limestone. Occurrences of graphite are associated with metasedimentary rocks which have been subjected to several deformations and where metamorphism has reached amphibolitic or granulitic phases.

Graphite also occurs in Esmanvile township, south of Fermont. Several graphite-rich schist zones, measuring 1 to 25 m in thickness, are found interlayered with quartz-feldspar gneiss. Some graphite zones locally contain more than 15% graphite in the form of fine and well-crystallized flakes.

In Ontario, graphite deposits are found in several townships of eastern Ontario in rocks of the Grenville Geological Province. Flake graphite occurs disseminated in marbles and gneiss. The occurrences of major interests are in semipelitic and pelitic gneiss units within paragneiss sequences. Graphite is present in amounts up to 10%. Accessory minerals consist of biotite, garnet and pyrite; trace elements in these graphitic rocks are nickel, cobalt, boron and vanadium.

CANADIAN PRODUCTION, EXPLORATION AND DEVELOPMENT

In 1989, Canada's production of graphite came from Asbury Graphite Quebec Inc. of Notre-Dame-du-Laus, Quebec. Asbury Graphite is a subsidiary of Asbury Carbons Inc. of the United States, a holding company with mining operations in Canada and Mexico, and custom processing plants in the United States for grinding, screening and blending graphite ores and petroleum coke, along with other specialty carbon types.

At Notre-Dame-du-Laus, the Asbury Graphite operation, which is managed by Stratmin Inc. of Montreal, operates a small open-pit mine and a mill. The ore is a disseminated flake graphite in crystalline limestone associated with biotite quartzite. Graphite ore grades are between 7% to 10% carbon content, averaging 8% carbon. Open-pit reserves are estimated at some 250 000 t. Asbury Graphite produces flaky graphite in three sizes -400 um, 150-400 um, and -150 um with a carbon content of 85% to +90%. Approximately 70% is flakes and 30% is powder.

The year 1989 was marked by active exploration and development work in both Ontario and Quebec. The major companies involved were Cal Graphite Corporation, Stewart Lake Resources Inc., North Coast Industries Ltd. and Victoria Graphite Inc. in Ontario, and Stratmin Inc., Mazarin Mining Exploration Inc. and Exploration Graphicor Inc. in Quebec.

Cal Graphite Corporation of Lively, Ontario, holds a 100% interest in mining claims in the Township of Butt near Huntsville where crystalline flake graphite occurs in mafic gneiss and paragneiss. Since 1985, Cal Graphite Corporation has undertaken exploration work and in 1988, the company reported it had outlined some 60 Mt of proven and probable reserves grading almost 3% graphitic carbon measured by double ignition loss. An open-pit mine and a processing plant with an initial milling capacity of 3000 t/d ore, which could be expanded to 5000 t/d ore, is under construction. Production is expected to start in mid-1990. Although the grade of the ore is relatively low, the company reports that only light crushing will be necessary to free the crystalline flakes, and a simple upgrading process including autogenous rotary crushing and vertical column flotation will be used. Flake graphite concentrates grading 90% to 94% carbon will be sold to crucible, lubricant and refractory companies, mainly in the United States and Europe. A refinery (leaching plant) to produce higher grade concentrates for specialty application is under construction at Walden near Sudbury. Premetalco Inc., a subsidiary of Preussag AG of West Germany, will be the exclusive agent for worldwide marketing of production.

Stewart Lake Resources Inc. of Oakville, Ontario announced the completion of the feasibility study on its Kirkham, Ontario flake graphite project by Kilborn Limited. The study concluded that the project can be successfully developed and placed into production at an estimated cost of $9.8 million. Graphite ore will be mined by open-cast method at the beginning, moving to an underground operation eventually. Mining would proceed five days a week at about 350 t/d ore and milling seven days a week at 250 t/d ore, yielding approximately 8000 t/y of graphite concentrate. Stewart Lake's schedule calls for construction to begin by late 1990 with full-scale production in early 1991. The mining plan is based on mineable, diluted reserves of just over 1 Mt, grading 8.61% graphitic carbon -- sufficient for about 12 years of operation. However, the company reported that drill results indicate that an expansion of mineable reserves is achievable, which will support a longer operation. Stewart Lake also reported that negotiations are under way with end users to secure medium- to long-term marketing contracts for the concentrate. Discussions are also taking place in order to obtain the funds necessary to build the production facilities and initiate mining.

Victoria Graphite Inc. completed a surface drilling program at its graphite deposit near Portland, Ontario where graphite occurs in silicated marble in three steeply dipping zones. The ore is reported to average 6% graphitic carbon down to 20 metres in two zones. The company is gearing up for pilot production with a mill capacity of some 100 t/d ore using an existing mill building on the site and second-hand equipment. Assuming market acceptance, the company plans to construct a new building and mill which would have a capacity of 300 t/d ore. Samples sent to Lakefield Research indicated that the graphite would be suitable for the production of exfoliated graphite used in the manufacture of graphite foil.

North Coast Industries Ltd. of Vancouver, B.C. completed the feasibility study for its flake graphite project in Bissett Creek, Ont. and is negotiating a joint venture with a major foreign mining company. North Coast is proposing an annual production of 17 000 t of marketable flake graphite grading 90% to 92% carbon. North Coast owns 100% of the project, having acquired the 42% it did not own from BFD Industries Ltd. (formerly Canadian Graphite Ltd.). The company has an agreement with Possehl of West Germany for the marketing of its production. The deposit has established reserves of 20 Mt of proven and probable flake graphite ore with an average grade of 3.2% carbon.

Stratmin Inc. of Montreal, Quebec and Asbury Graphite Mills Inc. of Asbury, New Jersey have reached a fifteen-year agreement with options for subsequent five-year renewals. The agreement calls for Stratmin to lease and operate Asbury's milling facilities in Notre-Dame-du-Laus, Quebec. The mill has been modified and winterized, and production capacity has been increased to 9000 t/y concentrate. Asbury is committed to purchase the total production of the first year and a minimum of 10 000 t/y concentrate for a minimum of five years, with provision for subsequent five-year renewals. Stratmin is building a mill with a production capacity of 20 000 t/y concentrate at its Lac-des-Îles graphite property near Mont-Laurier, Quebec and construction should be completed in early 1990. Total reserves (proven, probable, possible) of Stratmin's Lac-des-Îles properties are 23.7 Mt averaging 7.5% carbon. Mining will be by open-cast method from four pits. Concentrates of 92% to 98% carbon will be produced. At year-end, Stratmin announced it would receive $19.5 million from Elders Resources Limited of Australia for the sale of a 50% interest in its Lac-des-Îles project.

At year-end, Mazarin of Quebec City, Que. was negotiating an agreement with Cassiar Mining Corporation of Vancouver, B.C. to jointly develop its Fermont, Que. graphite property. Under the agreement, Cassiar would invest $14 million in exchange for a 50% interest in the project. Cassiar would pay $5 million to Mazarin for Mazarin shares and $9 million directly into the project through a specially created subsidiary. The feasibility study on putting the property into production was recently completed and concluded that construction of the project would cost $32.6 million. The study proposes an open-pit mining operation for six months of the year, which would supply enough ore to feed a 400 t/d concentrator on a year-round basis for an annual production of 20 000-23 000 t. Production is scheduled to begin in 1991. The property's reserves (proven, probable and possible) are estimated at 8.75 Mt, averaging 14.2% graphitic carbon after dilution.

Exploration Graphicor Inc. of Ste-Scholastique, Quebec, started the construction of a mill near Notre-Dame-du-Laus, Quebec. The mill is expected to produce some 500 t/d ore when production starts. Exploration Graphicor Inc. owns three graphite deposits in the area and the ore grades approximately 8%.

CANADA, CONSUMPTION AND TRADE

Reported consumption of graphite in 1988 amounted to 15 644 t. Graphite was mainly used in foundries, metallurgy and refractories. Nearly all production of graphite produced by Asbury Graphite is exported to its parent company in the United States.

In 1989, imports of crude graphite for the first nine months were valued at $1.57 million. Some 90% of Canada's imports originate from the United States. Crude graphite is used mainly in Ontario (70%) and Quebec (15%).

USES AND SPECIFICATIONS

The uses of natural graphite depend on its physical and chemical properties. The strength of graphite increases as its temperature rises. It has a high thermal conductivity and a low absorption coefficient for x-rays and electrons.

Flake graphite is used in the manufacture of crucible for the steel, nonferrous and precious metals industries. It is preferred to microcrystalline graphite because it burns more slowly, has a high attrition resistance and imparts structural strength through the orientation of the flakes.

Carbon refractories consist of more than 7% carbon in a blend with either microcrystalline or flake graphite, and are known as magnesia carbon brick. Mag-Carbon brick is used in high temperature and corrosion-prone applications such as in steel furnace lining, ladles, slag-lines, hotpots, nozzles and blast furnaces. Graphite is used because of its thermal conductivity, and thermal and chemical resistances. Flake graphite must have a carbon content between 90% and 97% and sizes ranging from 75 to 180 microns.

The use of graphite in brake linings reduces the wear rate. High-carbon, fine crystalline graphite, below 75 microns, is used with a minimum carbon content of 98%, although a concentrate of 90% can be used if abrasive impurities such as silica are at a low level.

Traditionally, graphite has been used in dry-cell zinc-carbon batteries due to its electrical conductivity. Fine-grain carbon, below 75 microns, or microcrystalline graphite with a minimum carbon content of between 85% and 90% is required. Alkaline batteries require a purer natural graphite with a carbon content of at least 98% or a synthetic grade. Carbon material should be free of metallic impurities such as copper, cobalt or antimony.

Electric motor components use a wide variety of graphite, natural or synthetic. Powdered graphite, 150 microns, with a minimum carbon content of 95% to 99% is required. Lump graphite, low-silica microcrystalline graphite and synthetic graphite are usually suitable.

In powder metallurgy where steel is reinforced by the absorption of carbon, high-purity graphite is required for the sintering. It also acts as a lubricant and as a source of carbon. Dry powder graphite should be of an average particle size of five microns and must have a carbon content of between 96% and 99%.

Lubricants for industrial usage are also made from graphite because of its softness, low friction, inertness and heat resistance. High-carbon, fine crystalline graphite, below one micron, is specified with a carbon content of between 96% to 99%.

In paint manufacture, graphite is used to protect metal surfaces exposed to a corrosive environment and to eliminate the accumulation of static electricity in floor coatings. Microcrystalline graphite of low carbon content, 50% to 55%, is usually required.

In the manufacture of lead pencils, natural graphite is used because of its marking properties. The degree of hardness of a pencil is determined by the clay-to-graphite ratio of its lead. Microcrystalline graphite, 80% to 82%, is used in the cheaper grades of leads. However, a finely ground graphite with a higher carbon content, over 90%, is usually required.

For foundry application such as mould coating, graphite prevents the adhesion of metals. Foundry facings are usually made of lump graphite or microcrystalline graphite, between 53 to 75 microns, with a low carbon content of 40% to 70%.

Iron foundries use microcrystalline graphite as a recarburizer for raising the carbon content of iron melted in electrical furnaces from charges containing large proportions of scrap. A wide variety of material may serve as a substitute, such as synthetic graphite and coke.

Other uses for natural graphite include engineering components, polishes, rubber products and explosives.

Expected growth areas are in the use of **flake** graphite. Growing markets include exfoliated flake graphite rolled into sheet for the manufacture of gaskets and seals used in the automotive industry, heat exchangers, etc., and in the form of expanded graphite for use as a fire-retardant in foam-filled furniture; high alumina and magnesia graphite bricks for the refractory industry; zirconia-graphite; alumina-SiC-graphite refractories; and friction materials. Other growing markets are very high-purity graphite for specialty applications; metal powders and motor brushes.

WORLD PRODUCTION, TRADE AND CONSUMPTION

Preliminary figures for 1987 indicated that world production of natural graphite was 660 000 t, about the same as in 1986. Some 40% was flake graphite. China was the largest producer with 185 000 t, followed by South Korea (97 000 t), the U.S.S.R. (83 000 t), Czechoslovakia (59 000 t), India (38 000 t), Brazil (37 000 t), and Mexico (36 000 t). As indicated in Table 2, world production has increased 213 000 t/y from 1976 to 1986; this represents about 21 000 t/y, or the size of a large graphite mining operation.

The major world producer countries, by type of graphite and by decreasing order of importance, are as follows:

Flakes:
China, Brazil, India, U.S.S.R., Madagascar, West Germany and Norway.

Microcrystalline:
China, South Korea, Mexico, Czechoslovakia, Austria, U.S.S.R., North Korea and Zimbabwe.

Lump:
Sri Lanka.

A resume of the largest exporter and importer countries of graphite in recent years is as follows:

MAJOR EXPORTER AND IMPORTER COUNTRIES OF GRAPHITE IN RECENT YEARS

	Exports (000 t/y)		Imports (000 t/y)
China	70-80	United States	40-47
South Korea	35-45	West Germany	30-35
Mexico	20	United Kingdom	20-22
Madagascar	15	Taiwan	8
Zimbabwe	13	Italy	6
Austria	10	France	5
West Germany	10	Austria	4
Brazil	9		
Norway	5-7		
Japan	70-90		

The largest consumers of graphite are the large producers of iron and steel, base metals and precious metals. Together they consume about 50% of all graphite and are the largest users of flake graphite. The largest consumer countries are: the U.S.S.R., Japan, the United States, China, West Germany, the United Kingdom, Italy, France and Brazil.

PRICE

Published prices for natural graphite provide only a range of prices and are not representative of market prices which are contracted prices negotiated between suppliers or distributors and consumers. The prices of flake graphite and lump graphite are higher than those for microcrystalline (amorphous) graphite because of the nature of mining and processing operations. Prices for flake graphite concentrate vary, depending on the carbon content, the size of the flakes and their distribution, and the ash content.

Published prices remained the same as in 1988.

OUTLOOK

Graphite has excellent physical and chemical properties; its resource base is large and it is readily available from several countries. For these reasons, growth should continue.

The grade of Canadian deposits discovered so far is generally lower than that of most producers in the world. Also, labour costs in Canada are relatively high compared to those in many producing countries. However, Canadian deposits are of the flake type, are relatively easy to upgrade to +90% carbon, and many contain graphite that is expandable. These products command high prices and the outlook for growth is good. Countries that rely mainly on China and Madagascar for their supplies of flake graphite may wish to diversify their sources and purchase concentrates from closer sources in eastern Canada.

Note: *Information contained in this review was current as of mid-January 1990.*

PRICES

"Industrial Minerals"[1] pricing quotation, c.i.f., United Kingdom port, US$ per tonne

		Dec. 1984	1988		1989
			Nov.	Dec.	Dec.
Crystalline lump	92-99% C	550 - 1 100	550 - 1 100	750 - 1 500	750 - 1 500
Crystalline large flake	85-90% C	630 - 1 000	630 - 1 000	820 - 1 300	820 - 1 300
Crystalline medium flake	85-90% C	490 - 860	490 - 860	770 - 1 120	770 - 1 120
Crystalline small flake	80-95% C	300 - 800	300 - 800	540 - 900	540 - 900
Powder (200 mesh)	80-85% C	250 - 275	250 - 275	325 - 360	325 - 360
	90-92% C	410 - 460	410 - 460	520 - 600	520 - 600
	95-97% C	550 - 750	550 - 750	770 - 1 000	770 - 1 000
	97-99% C	750 - 1 000	750 - 1 000	1 000 - 1 300	1 000 - 1 300
Amorphous powder	80-85% C	175 - 350	175 - 350	220 - 440	220 - 440

"Chemical Marketing Reporter"[2] pricing quotation, New York, U.S. basis, bags, drums, US$ per pound

		1987	1988	1989
Crystalline, powder	88-90%	.30 - .60	.30 - .60	.30 - .60
	90-92%	.40 - .70	.40 - .75	.40 - .75
	95-96%	.60 - .90	.60 - .90	.60 - .90
	97% and up	.80 - 1.20	.80 - 1.20	.80 - 1.20
Flake	No. 1 (large), 90-95%	.65 - .75	.65 - .75	.65 - .75
	No. 2 (medium), 90-95%	.65 - .75	.65 - .75	.65 - .75
	No. 3 (small), 90-95%	.65 - .75	.65 - .75	.65 - .75
Amorphous	powder	.16 - .40	.16 - .40	.16 - .40
	powder, 97% and up	.80 - 1.20	.80 - 1.20	.80 - 1.20

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[1] "Industrial Minerals", December 1984, November and December 1988, and December 1989. [2] "Chemical Marketing Reporter", December 1987, December 1988, and December 1989.

c.i.f. Cost, insurance and freight.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.04	Natural graphite				
2504.10.10	--- in powder	9.2%	6%	Free	Free
2504.10.20	--- in flakes	4%	2.5%	Free	Free
69.02	Refractory bricks, blocks, tiles and refractory constructural ceramic goods, other than those of siliceous fossil meals or similar siliceous earths				
6902.90	-- Other				Free - 4.9%
6902.90.10	--- containing by weight 85% or more of carbon or graphite	6.8%	4.5%	5.4%	Free - 4.9%
6902.90.90	--- Other, containing by weight more than 50% but less than 85% of carbon or graphite	Free	Free	Free	Free - 4.9%
69.03	Other refractory ceramic goods, other than those of siliceous fossil meals or of other similar siliceous earths				
6903.10	- containing by weight more than 50% of graphite or other forms of carbon or of a mixture of these products				
6903.10.10	- crucibles and covers therefor	6.8%	Free	5.4%	4.9%
8545.20	Carbon or graphite brushes	10.2%	6.5%	8.1%	3.7%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. IMPORTS OF CRUDE GRAPHITE AND GRAPHITE RELATED PRODUCTS, 1988 AND 1989

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
2504.10	Natural graphite in powder or flake				
	United States	3 210	2 609	1 303	1 372
	Switzerland	67	337	-	-
	West Germany	55	49	-	-
	Other countries	49	72	146	200
	Total	3 383	3 069	1 451	1 574
6902.90	Refractory bricks, etc. n.e.s., (containing by weight more than 50% carbon or graphite)				
	United States	185 586	36 762	28 185	21 772
	United Kingdom	1 330	1 609	1 867	1 486
	West Germany	4 718	3 418	775	2 364
	Japan	2 291	4 722	704	1 429
	Austria	4 155	167	26	20
	Other countries	348	439	530	323
	Total	198 433	47 123	32 089	27 399
6903.10	Refractory ceramic goods, n.e.s., more than 50% of graphite or other forms of carbon, etc. (including crucibles)				
	United States	..	1 527	..	1 521
	United Kingdom	..	269	..	220
	France	..	210	..	205
	Other countries	..	388	..	85
	Total	..	2 398	..	2 033
8545.20	Carbon or graphite brushes				
	United States	391	3 121	105	2 975
	West Germany	11	153	2	110
	Japan	11	109	3	117
	France	-	-	2	37
	Other countries	3	37	1	31
	Total	416	3 426	113	3 274

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; .. Not available; n.e.s. Not elsewhere specified; - Nil.
Note: Totals may not add due to rounding.

TABLE 2. GRAPHITE, WORLD PRODUCTION, ALL TYPES, 1976 AND 1984-86

Country	1976	1984	1985	1986^p	Type of Graphite
		(tonnes)			
China^e	50 000	184 000	185 000	185 000	flakes, microcrystalline
U.S.S.R.^{e}	95 000	80 000	82 000	82 600	flakes, microcrystalline
Czechoslovakia^e	45 000	50 000	59 000	59 000	microcrystalline
South Korea	42 330	56 250	69 900	96 600	microcrystalline
(South Korea)	-	2 300	1 600	640	flakes
Mexico	60 000	40 000	33 500	35 950	microcrystalline
(Mexico)	-	1 500	1 900	1 840	flakes
Austria	33 000	43 790	30 770	36 200	microcrystalline
India	38 300	36 000	27 340	38 400	flakes, run of mill
Brazil	6 000	32 600	43 670	37 000^e	flakes
North Korea^e	20 000	25 400	25 400	25 400	microcrystalline
Madagascar	17 000	13 550	14 000	16 200	flakes
Zimbabwe	8 100	12 300	10 450	15 000	microcrystalline
West Germany	14 000	12 400	12 800	13 200	flakes
Sri Lanka	8 200	5 600	7 400	7 450	crystalline vein
Norway	9 000	9 500	2 300^e	-	flakes
Others	9 800	19 910	16 930	17 820	all types
Total	455 400	625 100	623 960	668 300	

Source: U.S. Bureau of Mines, Graphite by Harold Taylor, 1987.
^{p} Preliminary; ^{e} Estimated; - Nil.

TABLE 3. REPORTED CONSUMPTION OF GRAPHITE IN CANADA, 1975, 1980, AND 1984-88

	1975	1980	1984	1985	1986	1987	1988p3
				(tonnes)			
Reported consumption[1] of graphite							
Foundry facing	3 822	3 078	5 297	6 132	10 294	10 003	6 650
Ferroalloys and primary steel	568	468	475	398	795	950	639
Refractories	523	583	761	472	757	740	673
Other[2]	429	1 788	1 887	1 335	1 911	2 710	7 682
Total	5 342	5 917	8 420	8 337	13 757	14 403	15 644

[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants. [2] Includes brake linings, chemicals, abrasives, batteries and other end-uses. [3] Increase in number of companies surveyed.
p Preliminary.

TABLE 4. UNITED STATES IMPORTS FOR CONSUMPTION OF NATURAL GRAPHITE, BY COUNTRY

	Crystalline Flake		Lump or Chippy Dust		Other Natural Crude and Refined		Amorphous		Total[1]	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(short tons)	($000)	(short tons)	($000)	(short tons)	($000)	(short tons)	($000)	(short tons)	($000)
1986	4 821	3 122	2 054	1 914	18 115	9 796	17 800	925	42 790[2]	15 758[2]
1987										
Austria	-	-	-	-	-	-	82	37	82	37
Belgium-Luxembourg	-	-	-	-	37	13	-	-	37	13
Brazil	1 019	622	-	-	4 763	2 754	-	-	5 782	3 376
Canada	977	554	-	-	1 152	548	-	-	2 129	1 102
China	1 827	963	-	-	9 096	3 222	741	80	11 664	4 265
France	-	-	-	-	108	163	-	-	108	163
Germany, Federal Republic of	22	99	-	-	269	761	-	-	291	860
Hong Kong	-	-	-	-	-	-	59	8	59	8
India	39	15	-	-	348	284	-	-	387	299
Japan	83	295	-	-	403	780	-	-	486	1 075
Madagascar	2 519	2 086	-	-	1 325	975	-	-	3 844	3 061
Mexico	-	-	-	-	1 392	683	19 321	998	20 713	1 682
Netherlands	-	-	-	-	20	28	-	-	20	28
Seychelles	-	-	-	-	20	13	-	-	20	13
South Africa, Republic of	-	-	-	-	176	89	-	-	176	89
Sri Lanka	-	-	1 402	1 137	-	-	-	-	1 402	1 137
Sweden	-	-	-	-	(3)	3	-	-	(3)	3
Switzerland	-	-	-	-	20	33	-	-	20	33
Taiwan										
United Kingdom	8	9	-	-	244	262	-	-	252	271
Venezuela	-	-	-	-	44	16	-	-	44	16
Zimbabwe	-	-	-	-	172	84	-	-	172	84
Other	82	39	-	-	(3)	1	-	-	82	40
Total[1]	6 574	4 683	1 402	1 137	19 589	10 710	20 203	1 123	47 768	17 654
1988										
Austria	38	25	-	-	-	-	67	39	105	64
Brazil	2 293	1 607	-	-	2 917	2 064	-	-	5 210	3 671
Canada	2 443	1 533	-	-	2 749	1 188	-	-	5 192	2 721
China	1 307	613	-	-	15 159	6 051	152	25	16 618	6 689
France	20	22	-	-	30	78	-	-	50	100
Germany, Federal Republic of	(3)	1	-	-	273	624	-	-	273	624
Hong Kong							144	53	144	52
India	-	-	-	-	243	207	-	-	243	207
Japan	21	83	-	-	247	635	-	-	268	718
Madagascar	2 882	2 169	-	-	1 468	1 032	-	-	4 350	3 201
Mexico	-	-	-	-	1 771	869	20 717	1 000	22 488	1 869
Netherlands	-	-	-	-	7	65	-	-	7	65
Seychelles	-	-	-	-	-	-	-	-	-	-
South Africa, Republic of	-	-	-	-	375	188	-	-	375	188
Sri Lanka	-	-	3 107	2 376	-	-	-	-	3 107	2 376
Sweden	-	-	-	-	1	1	-	-	1	1
Switzerland	-	-	-	-	131	108	-	-	131	108
Taiwan	-	-	-	-	15	3	-	-	15	3
United Kingdom	88	63	-	-	1	1	-	-	89	64
Venezuela	-	-	-	-	-	-	-	-	-	-
Zimbabwe	-	-	-	-	699	410	-	-	699	410
Other	1	4	-	-	12	101	-	-	13	105
Total[1]	9 093	6 120	3 107	2 376	26 098	13 625	21 080	1 117	59 378	23 238

Source: Bureau of the Census.

[1] Data may not add to totals shown because of independent rounding. [2] Data do not include artificial graphite. (3) Less than 1/2 unit.
- Nil.

TABLE 5. UNITED STATES CONSUMPTION OF NATURAL GRAPHITE, BY USE

Use	Crystalline		Amorphous[1]		Total[2]	
	Quantity	Value	Quantity	Value	Quantity	Value
	(short tons)	($000)	(short tons)	($000)	(short tons)	($000)
1987						
Batteries	W	W	W	W	1 102	1 702
Brake linings	1 627	1 408	2 643	2 745	4 270	4 153
Carbon products[3]	361	868	219	270	580	1 138
Crucibles, retorts, stoppers, sleeves, nozzles	W	W	W	W	1 506	1 411
Foundries[4]	436	281	4 345	1 321	4 781	1 602
Lubricants[5]	805	789	3 606	2 296	4 411	3 085
Pencils	1 857	2 047	271	164	2 129	2 211
Powdered metals	461	848	121	190	582	1 038
Refractories	W	W	W	W	8 300	3 682
Rubber	130	152	279	141	409	293
Steelmaking	167	111	1 369	538	1 536	649
Other[6]	73	163	2 487	2 750	2 560	2 913
Withheld uses	6 559	5 828	4 348	967	–	–
Total[2]	12 475	12 494	19 690	11 383	32 165	23 876
1988						
Batteries	W	W	W	W	886	1 340
Brake linings	1 960	1 666	3 656	3 389	5 616	5 055
Carbon products[3]	349	879	256	374	605	1 253
Crucibles, retorts, stoppers, sleeves, nozzles	W	W	W	W	1 809	1 818
Foundries[4]	513	283	4 307	1 247	4 820	1 530
Lubricants[5]	1 232	1 395	3 203	1 623	4 435	3 018
Pencils	1 666	1 746	334	174	2 000	1 920
Powdered metals	1 598	1 472	55	84	1 653	1 556
Refractories	W	W	W	W	8 137	4 352
Rubber	105	128	373	324	478	452
Steelmaking	207	116	1 271	1 405	1 478	1 521
Other[6]	147	303	3 002	4 177	3 149	4 480
Withheld uses	8 010	6 848	2 822	663	–	–
Total[2]	15 787	14 836	19 279	13 460	35 066	28 294

[1] Includes mixtures of natural and manufactured graphite. [2] Data may not add to totals shown because of independent rounding. [3] Includes bearings and carbon brushes. [4] Includes foundry facings. [5] Includes ammunition, packings and seed coating. [6] Includes paints and polishes, anti-knock and other compounds, soldering and/or welding, electrical and electronic products, mechanical products, magnetic tape, small packages, industrial diamonds and drilling mud.
W Withheld to avoid disclosing company proprietary data, included with "Withheld uses"; – Nil.

TABLE 6. SELECTED IMPORTS OF GRAPHITE

Country	1984	1985	1986	1987
		(tonnes)		
United Kingdom	19 540	23 460	23 101	19 729
France	4 578	5 277	5 572	5 864
West Germany	31 983	33 998	37 793	30 504
Italy	6 280	5 955	6 867	..
Netherlands	954	636	1 204	1 726
Spain	2 004	2 519	3 993	..
Austria	7 134	3 280	4 966	2 083
East Germany	5 712	6 634	5 289	..
Poland	7 445	6 082	3 929	..
Yugoslavia	2 220	2 267	2 234	2 415
South Africa	4 122	3 834	2 751	..
Mexico	14	46	-	..
United States	52 840	47 842	38 817	43 335
Venezuela	701	927	681	..
Hong Kong	1 545	1 499	3 685	4 104
India[1]	-	-	-	-
Indonesia	98	150	968	..
Japan	85 009	78 857	58 645	94 268
Korea, Republic of	1 260	1 084	3 180	..
Malaysia	1 183	908	510	..
Pakistan[2]	1 777	1 566	845	2 630
Taiwan	6 574	8 428	8 513	8 390
Australia	979	1 199	1 460	..

Source: British Geological Survey, World Mineral Statistics.

[1] Years ended March 31. [2] Years ended June 30.

- Nil; .. Not available.

TABLE 7. SELECTED EXPORTS OF GRAPHITE

Country	1984	1985	1986	1987
		(tonnes)		
United Kingdom	3 862	2 563	3 739	3 184
West Germany	12 210	11 522	9 844	10 287
Austria	11 552	11 826	10 284	8 330
Czechoslovakia[1]	2 800	3 100	2 800	..
Norway	8 888	6 161	954	56
U.S.S.R.[1]	–	–	–	..
Madagascar	14 527	16 125	13 595	..
Zimbabwe	11 989	15 440	14 700	12 503
Mexico	21 323	19 298	–	..
United States	6 667	9 240	13 089	15 000
Brazil	5 082	8 725	9 890	..
China[1]	78 800	71 800	80 100	..
Hong Kong (re-exports)	856	508	3 036	3 781
India[2]	1 871	1 043	–	..
Japan	2 927	2 553	2 666	2 019
North Korea[1]	11 000	5 800	4 600	..
South Korea	39 864	48 353	30 969	..
Sri Lanka	7 215	9 170	9 824	10 388
Taiwan	237	188	204	178

Source: British Geological Survey, World Mineral Statistics.
[1] British Geological Survey estimates, based on known imports into certain countries. [2] Years ended March 31.
- Nil; .. Not available.
Note: This table excludes synthetic graphite.

Gypsum and Anhydrite

1989

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Production of crude gypsum is mainly from Atlantic Canada, accounting for about 75% of output and nearly all of Canada's exports. Ontario production is used on-site, except in the case of Westroc Industries Limited at Drumbo, which ships to its Mississauga wallboard plant. Production from Manitoba and from Windermere, Canal Flats (Lussier River) and Falkland in British Columbia, supplies the Prairie Region and most of the British Columbia markets. Production was discontinued in New Brunswick.

In response to weaker demand for gypsum wallboard by the building construction industry in the United States, production (shipments) was about 11% lower than in 1988. Total Canadian shipments were 8.5 Mt in 1989, according to preliminary figures, compared to the revised figure of 9.5 Mt in 1988. Ontario shipments were slightly higher, against the national trend.

The portland cement industry requires up to 5% by weight of gypsum intimately ground with cement clinker to act as a set inhibitor. Amounts consumed may total more than 500 000 t/y in Canada.

CANADIAN DEVELOPMENTS

Canadian operations are largely subsidiaries of U.S. gypsum products manufacturers and production is in direct response to demand from the wallboard industry in the United States and Canada. In turn, this industry serves the building construction sector relating to residential, institutional and commercial projects. In recent years, housing starts have become a less-than-accurate indicator of the demand for gypsum wallboard because improved fire-retardant qualities, along with more renovation work, have encouraged broader use.

Domtar Inc. continued development at its new underground mine to supply the company's adjacent gypsum board complex at Caledonia, Ontario. This facility supplies 70 million m²/y of wallboard to construction and renovation markets in the United States and Canada. Development costs are estimated at $13 million and full production using continuous miners is planned in 1990 when existing reserves are exhausted. New reserves at present levels of output are expected to be sufficient for 75 years. In Manitoba, Domtar began opening a quarry in Amaranth to replace depleting reserves at Gypsumville. The company closed its wallboard plant in Saskatoon in 1988, with regional markets in the area now being served mainly from Winnipeg. Construction continued on the company's US$35 million gypsum board plant in Newington, New Hampshire, with start-up also planned in 1990. Planned initial annual capacity is about 33 million m²/y with this eventually rising to 50 million m²/y. Crude gypsum will be supplied from the company's Flat Bay, Newfoundland mining operation, thus assuring an ongoing major outlet for this property.

CGC Inc., a diversified public company owned 75% by USG Corporation of Chicago, continued work on its $7 million, six-year project at Hagersville, Ontario, initially to expand ore reserves. This is expected to assure a long-time availability of ore and to maintain output at about 650 000 t/y.

Westroc Industries Limited, a subsidiary of British-owned BPB Industries PLC and the major operator in western Canada along with Domtar, began a modernization and refurbishing plan at its operation in Winnipeg.

Louisiana-Pacific Corporation, of Portland, Oregon, proceeded with its $65 million fibre-gypsum board plant on Cape Breton Island. The plant will use recycled paper, local gypsum and imported perlite to produce about 22 million m²/y of finished product beginning in 1990. Output will mainly go to construction markets in the northeast and mid-Atlantic states, marking the first time that a finished board product of this type will be exported from Nova Scotia.

Two companies, Westroc and Domtar, plan to recycle waste gypsum from their product plants in the Toronto area. This will reduce the amounts of waste going to landfill sites and is expected to help reduce the costs of raw material inputs.

Eastern Gypsum Inc., a New Brunswick-based company, announced plans for a $40 million gypsum wallboard plant to be located in McAdam, New Brunswick.

Although gypsum is generally produced from deposits situated conveniently close to markets for related finished products, exceptions occur if deposits are of unusually high quality, if comparatively inexpensive mining methods are applicable, or if low-cost, high-bulk shipping facilities are applicable. Deposits in Nova Scotia and Newfoundland meet these criteria and have been operated for many years by, and for, U.S. companies.

Occurrences of gypsum other than those being exploited are known in the southwest lowlands west of the Long Range Mountains in Newfoundland; throughout the central and northern mainland of Nova Scotia as well as on Cape Breton Island; in the southeastern counties of New Brunswick; on the Magdalen Islands of Quebec; in the Moose River, James Bay and southwestern regions of Ontario; in Wood Buffalo National Park, in Jasper National Park, along the Peace River between Peace Point and Little Rapids, and north of Fort Fitzgerald in Alberta; on Featherstonhaugh Creek, near Mayook, at Canal Flats, at Loos and at O'Connor River in British Columbia; on the shores of Great Slave Lake, the Mackenzie, Great Bear and Slave rivers in the Northwest Territories; and on several Arctic islands.

WORLD DEVELOPMENTS AND TRADE

Gypsum occurs in relative abundance throughout the world; however, with dependence on the building construction industry, developments are generally limited to the industrialized countries. Reserves are extremely large and are conservatively estimated at over 2.5 billion t. Canada is the world's second largest producer of natural gypsum after the United States, together accounting for about 25% of world output.

Gypsum products, particularly wallboard, have limited market range because of high unit weight, friability, high transportation costs and relatively low unit values. These factors generally dictate that markets be supplied by the nearest producer. There are exceptions, however, and in addition to cross-border shipments between Canada and the United States, there have been shiploads of wallboard by European producers to ports in the southeastern United States. Imports into Canada and the United States from Mexico have increased. More recently, with strong demand, good prices, low production costs and competitive shipping arrangements, gypsum from Spain has become more important in North American markets. Canada-United States trade is usually in truckload lots of 20-25 t for delivery to warehouses or to job sites. During recent years, however, with strong demand extending the limits of trucking facilities, rail shipments have become common.

In the United States, there has been increased interest in flue-gas derived (FGD) gypsum and partial substitution of synthetic gypsum for natural gypsum has been accomplished at several wallboard plants. Exports of gypsum wallboard to the United States declined an estimated 50% in 1989, based on available preliminary data. Housing starts in the United States in 1989 were running about 8% behind 1988, based on 10-month data.

Imports from Mexico and the United States are used by both wallboard and cement producers in British Columbia. Imports from Spain are consumed by cement manufacturers.

PROCESSING AND MARKETS

Gypsum is a hydrous calcium sulphate ($CaSO_4.2H_2O$) which, when calcined at temperatures ranging from 120°-205°C, releases three quarters of its chemically combined water. The resulting hemihydrate of calcium sulphate, commonly referred to as plaster of paris, when mixed with water can be moulded, shaped or spread and subsequently dried, or set, to form a hard plaster. This is particularly suited to products including wallboard, lath and tile. Anhydrite, an anhydrous calcium sulphate ($CaSO_4$), is commonly associated geologically with gypsum but is not a suitable substitute for most uses.

The type of processing necessary depends upon end use. Crude gypsum is crushed, pulverized and calcined to form stucco, which may be mixed with water and aggregate (sand, vermiculite or expanded perlite) and applied over wood, metal or gypsum lath to form interior wall finishes. Gypsum wallboard, accounting for more than 70% of uses in North American markets, along with lath and sheathing, are formed by introducing a slurry of stucco, water, foam, pulp and starch between two unwinding rolls of absorbent paper resulting in a continuous "sandwich" of wet board. As the stucco hardens, the board is cut to predetermined lengths, dried, bundled and stacked for shipment. Gypsum for use in cement is crushed to -13 mm only. For agricultural or filler use it is dried and finely ground to about 100 mesh. Sheathing products may contain asphalt-impregnated paper along with asphalt added to the gypsum core to improve water resistance.

In addition to its use in the manufacture of portland cement as a set regulator, crude gypsum is used as a filler in paint and paper manufacture, as a substitute for salt cake (sodium sulphate) in glass manufacture and as a soil conditioner.

The use of lime or limestone mainly to desulphurize stack gases from utility plants, industrial plants burning high-sulphur fuel, or from sulphide ore smelting plants, results in the production of large amounts of waste gypsum in the form of a sludge presenting disposal problems. In Europe and Japan, by-product gypsum of this type is used in the manufacture of gypsum products by cement manufacturing plants, and also for soil stabilization. To further address the issues, ORTECH International plans to sponsor an international conference on FGD and chemical gypsum in Toronto in 1991.

By-product gypsum produced by the acidulation of phosphate rock in phosphate fertilizer manufacture has not been utilized in Canada despite available technology. In the case of phosphogypsum produced from sedimentary phosphate rock which can contain significant quantities of uranium and radium, studies have indicated that a potential radiation hazard exists.

Canadian Standards Association (CSA) Standards A 82.20 and A 82.35 relate to gypsum and gypsum products.

PRICES

Prices for gypsum in non-captive markets are negotiated, the only published figure being an approximate minimum price for crude material, ex-mine or c.i.f. United Kingdom, published in Industrial Minerals. Based on trends in the United States, prices for crude material, f.o.b. mine have fallen from US$8.54/t in 1985 to US$7.33 in 1988. The availability of lower-priced gypsum from Mexico and Spain has resulted in lower prices in some parts of the world.

OUTLOOK

Economic recovery, in the seventh year of expansion since 1982, slowed to an inflation-adjusted growth rate of about 2.0% in the third quarter of 1989. This weakness was a continuation of the downward trend beginning in 1988. Upward pressure on interest rates continued in 1989 and the general trend of Canadian business investment, including machinery and equipment, has been downward since the first quarter in 1988. In the case of non-residential construction, however, there has been stability since late 1988. Housing starts rose to 245 986 in 1987, decreased to 222 562 in 1988 and were about 215 000 in 1989. Uncertain factors in the outlook for building construction include relatively high short-term interest rates, the impact of the proposed 7% Goods and Services Tax before it replaces the existing manufacturing sales tax in 1991 and slightly higher consumer prices. Housing starts in 1990 are expected to decline to a more sustainable level of about 200 000 annually.

The Canadian Construction Association is predicting increases of about 4% (constant dollar expenditures) in the non-residential contract construction industry through the 1989-91 period. The construction industry as a whole has expressed concern that Canada's large infrastructure network deserves attention now rather than delaying until major renovation and upkeep projects are needed. Such a program would permit the construction industry, and the dependent portion of the mining industry, to plan five to ten years ahead with overall benefits in efficiency. The need for gypsum-based building products is expected to continue rising. Although new construction materials are being introduced, gypsum wallboard will remain popular because of its low price, ease of installation and well-recognized insulating and fire-retarding properties. The present structure of the industry in Canada is not expected to change greatly, although future availability of by-product gypsum based on satisfying stricter environmental controls will likely influence developments in some areas.

Both residential and commercial renovation work are expected to play a substantial role in the wallboard market, thus moderating major swings in demand. U.S. markets may strengthen based on growth in the western region and an outlook for more housing starts than the estimated 1.42 million in 1989.

ANHYDRITE

Production and trade statistics for anhydrite are included with gypsum statistics. Anhydrite is produced by Fundy Gypsum Company Limited at

Wentworth, Nova Scotia, and by Little Narrows Gypsum Company Limited at Little Narrows, Nova Scotia.

According to the Nova Scotia Department of Mines and Energy, production of anhydrite in 1988 was 142 000 t based on final figures and in 1989 was an estimated 122 000 t. Most output was shipped to the United States for use in portland cement manufacture and as a peanut crop fertilizer. Cement plants in Quebec and Ontario also used some Nova Scotia anhydrite.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2520.10.00	- Gypsum; anhydrite	Free	Free	Free	Free
68.09	Articles of plaster or of compositions based on plaster				
	- Boards, sheets, panels, tiles and similar articles, not ornamented				
6809.11	-- Faced or reinforced with paper or paperboard only				
6809.11.10	--- Gypsum wallboard	9.4%	Free	7.5%	2.1%
6809.11.90	--- Other	9.2%	Free	7.3%	2.1%
6809.19.00	-- Other	10.2%	6%	8.1%	5.4%
6809.90	- Other articles				
6809.90.10	--- Models and casts, of a kind used in the manufacture of dental prostheses	Free	Free	Free	3.8%
6809.90.90	--- Other	10.2%	6.5%	8.1%	3.8%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, GYPSUM PRODUCTION AND TRADE, 1988 AND 1989

Item No.		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production (shipments)					
Crude gypsum					
Nova Scotia		7 245 182	66 776	6 298 560	59 333
Ontario		1 452 739	15 716	1 491 915	13 556
Manitoba		419 356	4 936	356 076	4 356
British Columbia		x	x	x	x
Newfoundland		x	x	x	x
New Brunswick		x	x	–	–
Total[1]		9 511 581	92 544	8 456 798	81 519
Imports				**Jan.-Sept.**	
2520.10.00	Gypsum; anhydrite				
	Mexico	92 810	3 041	68 440	2 601
	United States	66 753	1 626	56 720	940
	Spain	115 058	1 030	93 137	611
	Other countries	295	8	734	32
	Total	274 917	5 707	219 031	4 188
		(square metres)		(square metres)	
6809.11	Plaster boards, etc. not ornamental; faced or reinforced with paper or paperboard				
	United States	18 044 555	19 748	14 010 642	15 569
	United Kingdom	. .	63	. .	156
	Italy	47 022	31	. .	1
	Total	18 091 577	19 844	14 010 642	15 727
6809.19	Plaster boards, etc. not ornamental; faced or reinforced, n.e.s.				
	United States	. .	548	. .	1 274
	United Kingdom	. .	158	-	-
	Italy	. .	5	-	-
	Total	. .	711	. .	1 274
6809.90	Articles of plaster or compositions based on plaster, n.e.s.				
	United States	. .	854	. .	577
	United Kingdom	. .	136	. .	415
	Italy	. .	272	. .	207
	Other countries	. .	23	. .	116
	Total	. .	1 287	. .	1 319
	Total imports of gypsum and gypsum products	. .	27 549	. .	22 508

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
2520.10.00	Gypsum; anhydrite				
	United States	5 615 039	51 917	4 406 474	41 020
	Netherlands	19	15	59	65
	Denmark	38	42	40	41
	Other countries	36 191	598	2	8
	Total	5 651 286	52 576	4 406 575	41 135
		(square meters)		(square meters)	
6809.11	Plaster boards, etc. not ornamental; faced or reinforced with paper or paperboard				
	United States	. .	77 351	27 019 335	25 178
	United Kingdom	-	-	100 000	7
	West Germany	-	-	344 856	6
	St. Pierre-Miquelon	. .	21	680	4
	Other countries	. .	164	-	-
	Total	. .	77 541	27 464 871	25 196
6809.19	Plaster boards etc. not ornamental; faced or reinforced, n.e.s.				
	United States	. .	6 949	. .	6 165
	Saudi Arabia	-	-	. .	319
	Cyprus	-	-	. .	36
	United Kingdom	. .	26	. .	18
	Other countries	-	153	-	-
	Total	. .	7 132	. .	6 539
6809.90	Articles of plaster or compositions based on plaster				
	United States	. .	915	. .	629
	France	. .	15	. .	15
	Bermuda	. .	28	. .	14
	West Germany	. .	43	. .	12
	East Germany	-	-	. .	3
	Other countries	. .	222	-	-
	Total	. .	1 226	. .	674
	Total exports of gypsum and gypsum products	. .	138 475	. .	73 544

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Totals do not include gypsum produced or shipped for use by Canadian portland cement producers.
p Preliminary; . . Not available; - Nil; x Confidential; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, GYPSUM MINING AND GYPSUM PRODUCTS MANUFACTURING OPERATIONS, 1989

Company	Location	Operation
Newfoundland		
Domtar Inc.[1]	Flat Bay	Open-pit mining
Atlantic Gypsum Limited	Corner Brook	Wallboard manufacture
Nova Scotia		
Domtar Inc.	McKay Settlement Windsor	Open-pit mining Plaster and "Gypcrete" manufacture
Fundy Gypsum Company Limited	Wentworth and Miller Creek	Open-pit mining of gypsum and anhydrite
Georgia-Pacific Corporation	River Denys, Sugar Camp	Open-pit mining of gypsum
Little Narrows Gypsum Company Limited	Little Narrows	Open-pit mining of gypsum and anhydrite
National Gypsum (Canada) Ltd.	Milford	Open-pit mining of gypsum
New Brunswick		
Lafarge Canada Inc.	Havelock	Open-pit mining of gypsum for cement manufacture ceased
Quebec		
CGC Inc.	Montreal St-Jerome	Wallboard manufacture Wallboard manufacture
Domtar Inc.	Montreal	Wallboard plant now used only as distribution terminal
Westroc Industries Limited	Ste. Catherine d'Alexandrie	Wallboard manufacture
Ontario		
CGC Inc.	Hagersville	Underground mining and wallboard manufacture
Domtar Inc.	Caledonia	Underground mining and wallboard manufacture
Westroc Industries Limited	Drumbo Clarkson	Underground mining Wallboard manufacture

Manitoba		
Domtar Inc.	Gypsumville	Open-pit mining
	Winnipeg	Wallboard manufacture
Westroc Industries Limited	Amaranth	Open-pit mining
	Winnipeg	Wallboard manufacture
Saskatchewan		
Domtar Inc.	Saskatoon[1]	Closed wallboard manufacturing plant in 1988
Alberta		
Domtar Inc.	Calgary	Wallboard and "Gypcrete" manufacture
	Edmonton[1]	Wallboard manufacture
Westroc Industries Limited	Calgary	Wallboard manufacture
British Columbia		
Domtar Inc.	Canal Flats	Open-pit mining
	Vancouver	Gypsum products manufacture
Westroc Industries Limited	Vancouver[2]	Gypsum products manufacture
	Windermere	Open-pit mining

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[1] Genstar Corporation affiliated operation acquired by Domtar Inc. in June 1985. [2] Genstar plant in Vancouver acquired by Westroc Industries Limited in June 1985.

TABLE 3. CANADA, GYPSUM PRODUCTION, TRADE AND CONSUMPTION, 1975, 1980-89

	Production[1]	Imports[2]	Exports	Apparent Consumption[3]
		(tonnes)		
1975	5 719 451	553 338	3 691 676	2 083 113
1980	7 336 000	154 717	4 960 240	2 530 477
1981	7 025 000	143 500	5 094 873	2 073 627
1982	5 987 000	93 843	4 775 755	1 305 088
1983	7 507 000	100 939	5 187 032	2 420 907
1984	7 775 082	131 809	6 224 574	1 682 317
1985	7 760 783	121 802	5 879 664	2 002 921
1986	8 802 805	221 644	5 921 982	3 102 467
1987	9 093 926	217 625r	5 704 853r	3 606 698r
1988[4]	9 511 581	274 917	5 651 286	4 135 212
1989p	8 456 798	219 031	4 406 575	4 269 254

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Producers' shipments, crude gypsum. [2] Includes crude and ground, but not calcined. [3] Production plus imports minus exports. [4] Beginning in 1988; imports and exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Imports and exports include H.S. class 2520.10.00 gypsum; anhydrite.

p Preliminary; r Revised.

TABLE 4. CANADA, HOUSE CONSTRUCTION, BY PROVINCE, 1987 AND 1988

	Starts			Completions			Under Construction		
	1987	1988	% Diff.	1987	1988	% Diff.	1987	1988	% Diff.
Newfoundland	2 682	3 168	18.1	2 836	3 220	13.5	3 631	3 491	-3.9
Prince Edward Island	933	1 151	23.4	943	993	5.3	338	497	47.0
Nova Scotia	6 460	5 478	-15.2	6 488	5 793	-10.7	3 283	2 915	-11.8
New Brunswick	3 716	3 621	-2.6	3 944	3 798	-3.7	1 524	1 317	-13.6
Total (Atlantic Provinces)	13 791	13 418	-2.7	14 211	13 804	-2.9	8 776	8 220	-6.3
Quebec	74 179	58 062	-21.7	68 949	65 224	-5.4	28 974	21 372	-26.2
Ontario	105 213	99 924	-5.0	88 609	88 727	0.1	64 458	74 465	15.4
Manitoba	8 174	5 455	-33.3	7 627	5 621	-26.3	4 765	4 409	-7.5
Saskatchewan	4 895	3 856	-21.7	5 640	4 352	-22.8	2 457	1 885	-23.3
Alberta	10 790	11 360	5.3	9 334	11 201	20.0	4 331	4 407	1.8
Total (Prairie Provinces)	23 859	20 671	-13.4	22 601	21 174	-6.3	11 553	10 701	-48.2
British Columbia	28 944	30 487	5.3	23 606	27 603	16.9	13 986	16 694	19.4
Total Canada	245 986	222 562	-9.5	217 976	216 532	-0.7	127 747	131 452	2.9

Source: Canada Mortgage and Housing Corporation.

TABLE 5. CANADA, VALUE OF CONSTRUCTION[1] BY TYPE, 1987-89

	1987	1988	1989
		($ millions)	
Building Construction[2]			
Residential	35 825	38 660	39 295
Industrial	3 244	3 560	3 678
Commercial	12 378	13 579	14 289
Institutional	4 314	4 512	4 967
Other building	2 147	1 415	2 848
Total	57 908	62 727	65 078
Engineering Construction[2]			
Marine	317	489	637
Highways, airport runways	5 433	5 633	5 987
Waterworks, sewage systems	2 304	2 920	3 333
Dams, irrigation	307	311	369
Electric power	3 616	4 824	5 616
Railway, telephones	2 922	3 051	3 475
Gas and oil facilities	6 030	7 450	7 447
Other engineering	3 135	3 310	3 255
Total	24 064	27 989	30 119
Total construction	81 971	90 715	95 197

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Actual expenditures 1987, preliminary actual 1988, intentions 1989. [2] Includes total value of new and repair work purchased.

TABLE 6. WORLD PRODUCTION OF GYPSUM, 1988 AND 1989

	1988	1989e
	(000 tonnes)	
United States	14 869	14 878
Canada	9 512	8 457
Iran	8 437	8 437
People's Republic of China	8 074	8 074
Japan	6 260	6 260
Spain	5 498	5 534
France	5 352	5 352
U.S.S.R.	4 808	4 808
Mexico	4 536	4 536
United Kingdom	3 538	3 538
Other market economy countries	20 924	21 047
Other central economy countries	4 403	4 445
World total	96 211	95 366

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines Mineral Commodity Summaries, January 1990.
e Estimated.

Iron Ore

1989

B.W. Boyd

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World iron ore production in 1989 recovered to a level not experienced since the 1970s. International trade in iron ore reached an all-time high. In spite of this performance, world production of iron ore fell short of demand. To fill the shortfall, a 17 Mt stockpile of ore, accumulated by Hamersley Iron Pty., Ltd. up to the end of 1987, was reduced to 9 Mt by the end of 1988 and was virtually eliminated in 1989. The tight market, recognized by both buyers and sellers, had a major effect on year-end price negotiations for deliveries in 1990.

The world price recovery in 1988 and 1989 produced an increase in the value of sales from Canadian iron ore mines. After nearly a decade of concern about survival, the iron ore industry in Canada operated near capacity in 1989 and attracted the interest of investors because of its potential for an attractive rate of return on investment.

CANADIAN DEVELOPMENTS

Six iron ore mines were again operating in Canada in 1989. Production was estimated at 40.6 Mt, representing 81% of capacity. Canadian shipments of iron ore increased 0.8 Mt to 40.9 Mt (natural weight), including shipments from stockpiles. The total value was estimated at $1.5 billion.

Employment at Canadian iron ore mines, concentrators, agglomerating plants and support services increased marginally during the last three years from 6500 to 6600.

Domestic steel production increased by 8% relative to 1988 and, as a consequence, Canadian demand for iron ore increased proportionately and totalled over 15 Mt. Because of the strong domestic demand, imports from the United States increased 20% to 5.2 Mt, and exports, estimated at 29.3 Mt, were about 4% lower than in 1988. As in past years, the largest market for Canadian iron ore was Western Europe which took over 16 Mt.

Canadian mines and ancillary plants produced concentrates, pellets and sinter from hematite, magnetite and siderite ores. The production of concentrate that was not further processed to pellets or sinter remained at 12.7 Mt/y. Acid pellet production amounted to 21.3 Mt in 1989, and fluxed pellet production increased 24% to 5.5 Mt. Over 1 Mt of sinter was produced at one mine.

The Iron Ore Company of Canada (IOC) shipped 15.1 Mt of iron ore of which 8.1 Mt was acid pellets, 1.7 Mt was fluxed pellets, 0.4 Mt was pellet fragments (included with acid pellets in the Canadian totals), and 4.7 Mt was concentrate. Also included was the last 177 000 t of the Schefferville red ore that had been stockpiled at Sept-Îles for the past five years.

IOC purchased ten 200 t trucks in 1989, and plans for 1990 include $16 million for a new electric mining shovel.

Quebec Cartier Mining Company (QCM) operated near capacity for the third year in a row to produce over 16.1 Mt of iron ore. Due largely to a change in ownership, QCM increased production of fluxed pellets threefold to a new high of 1.6 Mt. In addition, QCM shipped 6.6 Mt of acid pellets and nearly 8 Mt of concentrates. As in the past, most of the ore was exported, over 68% to Western Europe. QCM has purchased ten new pelletizing disks that will increase pellet plant capacity to 8.4 Mt/y.

USX Corporation sold its 100% interest in QCM to the Canadian steel company, Dofasco Inc. Dofasco in turn sold a 25% interest to Companhia Auxiliar de Empresas de Mineração (CAEMI) of Brazil and 25% to Mitsui & Co., Ltd. of Japan. QCM has retained the same management as before the sale, but some marketing functions will be enhanced by the participation of CAEMI.

Wabush Mines attained a new record level of production at 6.2 Mt of iron ore pellets in 1989, operating at 103% of nominal capacity. The products this year included fluxed and acid pellets containing 1% manganese (Mn) and acid pellets with 2% Mn. To handle the increase in the number of products, Wabush Mines commissioned a new stacker in the summer of 1989.

To meet environmental regulations, Wabush began work on a $50 million stack emission control program that is scheduled for completion by the end of 1991. Financing for the project is coming from Wabush's active owners: Acme Steel, Inland Steel Company, Finsider of Italy, Cleveland-Cliffs Inc., Stelco Steel and Dofasco Inc.

The ownership of Wabush Mines was in the process of change at year-end due to the continuing financial problems of The LTV Corporation and Wheeling-Pittsburgh Steel Corporation, two of the original owners. Under a proposed new structure for the joint venture, each of the remaining partners would increase their share. As a result, the Canadian steel firms, Stelco Inc. and Dofasco Inc., would have their interest raised to 56.6% from 42%.

The Algoma Ore Division (AOD) of The Algoma Steel Corporation, Limited operated above nominal capacity again in 1989. A major restructuring of the mine, mill and sinter plant at Wawa, Ontario in 1986 was supposed to have reduced production capacity to 900 000 t of superfluxed sinter. However, AOD produced 1 234 000 t in 1989, including the processing of 313 000 t of purchased iron oxides. The company has forecast that production in 1990 will approach 1.2 Mt again, and that even more purchased oxides may be processed.

In August, Algoma announced that it would halt underground development of the mine at Wawa in the first quarter of 1990. Production of superfluxed sinter from siderite ore and purchased oxides would continue until mid-1992. The company's president, however, added that Algoma would be evaluating an alternative procedure for treating the Wawa ore that might prolong the life of the operation. There were no further announcements by year-end on the fate of the mine and sinter plant.

As part of its long-term program to ensure a supply of iron ore suited to its blast furnaces at Sault Ste. Marie, Algoma invested in the Magnetite Project at the Tilden mine in Michigan, where production reached 7 Mt in 1989. Production in 1990 will likely be down slightly, to 6.6 Mt, due to the processing of more magnetite and less hematite ore.

Dofasco Inc.'s two mines in Northern Ontario, the Adams and Sherman, produced over 1 Mt of fluxed pellets each in 1989. Both mines operated their pellet plants the whole year and only the mines themselves had summer shutdowns, three weeks at Adams and five weeks at Sherman. Production at both mines was reduced by electrical power interruptions due to cold weather late in the year.

In March, Dofasco announced that its two mines would close on March 31, 1990. The mines have low ore grades and are relatively small in size, so they have not been able to compete with other sources of iron ore. The operations will run at full capacity until the closures. Approximately 700 employees will be affected. In addition to severance, early retirement and relocation programs available to the employees, Dofasco announced that a $4 million regional development fund would be provided to the adjacent communities and that municipal taxes would be paid for three years after the closures. As part of Dofasco's purchase of QCM, it contracted to take 2 Mt/y of fluxed pellets to replace the production that would be lost from the Sherman and Adams mines.

La Fosse Platinum Group Inc. reported that it intended to reopen a mine on leases that formerly belonged to IOC, near Schefferville, Quebec. La Fosse began stripping on the property and investigating overseas markets during the year.

WORLD DEVELOPMENTS

World trade in iron ore reached 209 Mt for the first six months of 1989, and is estimated to have reached a record 420 Mt for the year. The record world trade was led by exports from Brazil and Australia which established new records of their own, taking 26% and 25% of world trade respectively. The next largest exporters were the U.S.S.R. (10.5%), India (7.9%) and Canada (7.4%). Japan took 30% of world imports and the European Economic Community took 34%. Consistent growth in imports, however, has been more evident in such diverse markets as Taiwan, the Republic of Korea, Argentina, Saudi Arabia and Pakistan (imports combined amounted to 8.6% of the world total).

Canada exports about 75% of its iron ore and, although the largest single customer is the United States, western European destinations account for 54%. The Canadian industry is, therefore, very sensitive to competition from U.S. mines in the North American market, and to competition from the iron ore exporting countries that ship to the European market.

In the United States, steel production declined slightly but the high price of scrap encouraged the use of iron ore as a source of iron units. Ten months' data showed iron ore consumption at 3.4 Mt (5.8%) ahead of consumption during 1988, and all of the increase was taken from U.S. mines. Imports from Canada, at 6.0 Mt, were down 2.0 Mt, and imports from offshore, at 10.4 Mt, were up 2.1 Mt.

In mid-August, Cyprus Minerals Company of Denver completed its purchase of the former Reserve Mining Co. taconite properties in Minnesota, a mine, mill and pellet plant that had closed in July 1986 due to poor markets and financial problems. The operation has been renamed Cyprus Northshore Mining Corp. and production of taconite pellets is scheduled to begin in the first quarter of 1990 at a rate of 1.5 to 2.0 Mt/y. It is anticipated that sales will climb to 4 Mt/y by 1993.

Brazilian iron ore exports reached a record 110 Mt in 1989, due largely to expansion at the Carajas mine of Companhia Vale do Rio Doce (CVRD). During the years when the iron ore market was glutted, management at CVRD held back the production at the new Carajas mine to about 25 Mt/y, but when markets tightened, production was increased to 30 Mt in 1988 and 32 Mt in 1989. Another 3 Mt/y increase, planned for 1990, will bring the mine to its rated capacity. CVRD produced over 50 Mt from its six mines in the Itabira area, and plans to increase production there to 54 Mt in 1990. Another 9 Mt/y was produced from ore purchased from nearby mines belonging to other companies.

Brazil's second largest iron ore company, Minerações Brasileiras Reunidas SA (MBR), exported nearly 17 Mt in 1989, 2 Mt more than in the previous year and 2 Mt less than is forecast for 1990. MBR's largest mine, Aguas Claras, is expected to deplete its reserves in eight to ten years, but a new mine at Tamandua, with 210 Mt of high-grade reserves, is expected to be developed as a replacement in the next four years. For the time being, large-scale expansion of the mines in the area is limited by the capacity of the transportation and loading systems.

The record-breaking exports of Australia were due to exceptional performance at some mines and the sale of most of the 9 Mt of ore that remained at the end of 1988 from a stockpile at Dampier. Hamersley Iron Pty., Ltd. shipped a record 50 Mt from its two mines, Tom Price and Paraburdoo, and its stockpile in Dampier. In 1990, a third mine, at the Channar deposit, will start production but, even with the three mines, Hamersley is expected to produce and therefore ship only about 46 Mt.

Robe River Ltd., in Australia, used extensive overtime to raise production to 2 Mt/m and increased shipments to over 20 Mt in 1989. The company is considering changes to the transportation and loading facilities to permit long-term operation at the level of 23 to 24 Mt/y.

Hancock Prospecting Pty Ltd., of Australia, negotiated with the Levin Steel Works, in Hungary, for deliveries of 1.5 to 2 Mt/y of iron ore in exchange for high alloy steel.

Venezuela produced at its capacity of nearly 20 Mt in 1989 and exported about 13 Mt. A new direct-reduction plant was commissioned, and Venezuela plans to install more facilities to produce sponge iron for export. In the longer term, some of its iron ore exports will be replaced with sponge iron exports.

The Chilean iron ore industry had the best year since 1980 producing 7.6 Mt. The Romeral mine increased production in 1989 to over 4 Mt and plans call for continued operation at that level. At the Algarrobo operation, production has remained near 4 Mt/y of pellets. Plans call for opening the Colorados mine in January 1990 to feed the existing pellet plant, but no overall increase in pellet production is planned.

Sweden produced about 21.8 Mt in 1989, and exports reached 17.9 Mt. The Grängesberg mine closed at the end of the year and another of the smaller mines, Dannemora, is scheduled to close at the end of 1991. As a result, the country's production capacity will decline somewhat and exports will be reduced.

Mauritania succeeded in raising production to 10 Mt in 1988, but failed to reach the projected 12 Mt planned for 1989. Mauritania has contracts for most of the 12 Mt/y on the European market and intends to reach that production level in 1990. In the longer term, it is looking for financing to open a new mine at Mhaoudat, with reserves of 100 Mt and projected production at 6 Mt/y.

Liberian iron ore production dropped slightly when the Lamco joint venture mine closed due to political problems and depletion of ore. In neighbouring Guinea, plans for the Guinea Nimba mine took another step forward as agreement was reached between Guinea and Liberia on what each country would bring into a joint venture. The new mine will be based on concessions belonging to Mifergui-Nimba Co., in Guinea, and the ore will be shipped to the coast on the Liberian railway and exported through the Liberian port facilities. In addition, the Lamco mine is scheduled to reopen early in 1990 to provide bridging production, until Guinea Nimba is operational.

In the People's Republic of China, iron ore production has grown steadily but has not kept pace with the demand of its expanding steel industry. Imports now account for 10% of the People's Republic of China's iron ore requirements, and there is potential for the quantity to increase above the 12 Mt imported in 1989.

In March, the Association of Iron Ore Exporting Countries (APEF) suspended operation and closed its office in Geneva. For over a decade, APEF provided good and timely statistics on world iron ore trade and production. Therefore, when the office closed, a number of countries, including Canada, cooperated in setting up a trust fund under the United Nations Conference on Trade and Development (UNCTAD) to maintain the statistical functions on a temporary basis. The arrangement was successful in allowing the APEF economist to produce two reports during the year. The current plan is to terminate the trust fund in December 1990, by which time many nations expect a permanent institution for statistics and exchange of information to have been set up under UNCTAD.

UNCTAD DIALOGUE ON IRON ORE

The Intergovernmental Group of Experts on Iron Ore (IGE), under the United Nations Conference on Trade and Development (UNCTAD), met for the third and final time in Geneva, October 16 to 19, 1989. The IGE recommended to the Iron Ore Trade and Development Board of UNCTAD "that regular intergovernmental meetings of experts should be convened, with the participation of industry advisers, to exchange views on the iron ore situation and to review and enhance iron ore statistics." This recommendation obviates the need for a Fifth Preparatory Meeting on Iron Ore under the Integrated Program for Commodities.

The new group is expected to become a long-term institutional framework for iron ore that would provide market transparency through improved quality and comparability of published statistics, as well as dialogue among producing and consuming countries on supply/demand issues and related problems.

PRICES

Western Europe and Japan each import about one third of all the iron ore that is traded internationally. Buyers in Europe normally negotiate prices with the exporting companies in November and December for shipments in the following calendar year. Japanese buyers negotiate their contracts in the January-to-March period for shipment during the Japanese fiscal year, which begins April 1st.

In 1987, the contract talks dragged into April and settlement was reached with Japan before Europe, as European steel mills held out for what they hoped would be better arrangements than would be given to Japan. In the following two years, the process proceeded more quickly, but by year-end 1989, prices for deliveries to European mills for 1990 had not been settled, and industry sources thought that the Japanese might again settle first.

After six years of price cuts for fines and concentrates, an increase of 13% was realized for most contracts in 1989. This brought the price level back to the 1985 level, but still well below the peak established in 1982, both in current dollar terms and even further off in constant dollars. In general, prices for pellets and lump ore increased by 17.3%, which in some cases led to prices higher than the 1982 price in current dollar terms. Significantly, the price difference between pellets and fines increased to 21¢ on the basis of US¢/Fe unit.[1]

At year-end, price negotiations for deliveries in 1990 were focussed on the offer of steel mills in the Federal Republic of Germany and the demands of CVRD. When negotiations started, in October, the gap between the price offered and the price asked was close to 16¢/Fe unit. By year-end the Federal Republic of Germany mills had offered 29.5¢ for fines and CVRD was asking 33.5¢.

OUTLOOK

The long-term outlook for international iron ore sales is for growth at about 1%/y, in line with forecasted growth in the world steel output. However, iron ore market growth may lead steel production due to a tightening in the market for high quality ferrous scrap. Although there was a softening in scrap prices toward the end of 1989, the trends to higher prices, and general availability problems, are expected to continue. The factors driving this trend will continue to be the growing demand for scrap by electric furnaces, production of less self-generated scrap as continuous casting use increases, and a falling off in the quality of obsolete scrap as more alloyed and galvanized steel is recycled. The potential long-term strength of the scrap market will make iron ore more competitive as a source of iron units for the steel-makers.

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[1] Price is reported in cents, United States currency, for each percentage point of iron in a tonne of ore; e.g. at 30¢/Fe unit, ore grading 65% iron would bear a price of 65 x 30¢ = US$19.50/t.

Integrated steel plants have also been affected by increasingly strict environmental codes that are forcing the closure of some of the older sinter plants. As a result, there will be less sinter available for charging to blast furnaces, and the market for lump ore and pellets will continue to strengthen at the expense of the market for sinter fines and concentrates.

In the near term, steel production worldwide is forecast to stabilize or contract slightly, and a slowdown in steel-making has already been perceived in the main market areas for Canadian iron ore, Western Europe and the United States. The iron ore market will remain tight, however, since the 7-9 Mt shipped from the Hamersley stockpile last year will not be available to steel producers in 1990.

The possibility of iron shortages has raised the expectation that contracts for 1990 deliveries may be settled in January, and that a price increase of 15% or more will be applied to both fines and pellets. Forecasts have shown that shortages of ore, should they occur, will be felt first for pellets and, therefore, the price differential between pellets and concentrates is expected to be maintained at 21US¢/Fe unit.

Within Canada, since two iron ore mines are scheduled to close in 1990, the remaining operations will have to make up the lost 2 Mt of production. As a result, Canadian iron ore mines are expected to operate at close to capacity and total sales of the remaining operations may increase. The shift in product mix at QCM, toward more fluxed pellets and less acid pellets, will continue in order to meet the 2 Mt/y contracted to Dofasco. Exports of pellets from QCM will likewise be reduced, since its pellet plant was already operating at capacity last year and the shipments to Dofasco will raise domestic sales.

IOC is studying the possibility of reopening its 6 Mt/y pellet plant at Sept-Îles, but it must carefully consider the high capital investment necessary to refurbish the plant and meet environmental regulations.

The major Canadian iron ore mines are facing contract negotiations in the coming year, since the existing contracts expire in February 1990. Unions are aware of the companies' improved financial position and are expected to demand pay increases. The companies, in turn, have been carefully cutting costs for several years in an effort to remain competitive, and they regard the current financial situation as encouraging, but not as a guarantee of future earnings potential. The industry, being based largely on exports, is very sensitive to exchange rate changes over which it has no control.

Employment in the Canadian industry will drop by about 700 with the closure of Dofasco's two mines and a further decrease of over 300 will occur if the Algoma mine at Wawa closes in 1992. Nevertheless, the prospects are good for a healthy industry based on the remaining mines. The capital costs associated with the development of a new mine in Canada would not likely be justified, in view of the high-grade resources still available for development in South America, Africa and Australia. On the other hand, expansion of existing operations, especially pelletizing capacity, will likely be economic, if growth in the market continues as forecast.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, IRON ORE PRODUCTION AND TRADE, 1988 and 1989

		1988		1989^p	
		(tonnes)[1]	($000)	(tonnes)[1]	($000)
Production (mine shipments)					
	Newfoundland	20 506 923	695 759	21 119 380	788 239
	Quebec	16 433 082	x	16 127 000	x
	Ontario	2 934 399	x	3 463 463	x
	British Columbia	59 458	2 203	63 300	1 351
	Total[2]	39 933 862	1 323 249	40 773 143	1 492 921
Imports				(Jan.-Sept.)	
2601.11	Iron ore concentrates, non-agglomerated				
	United States	23 460	605	13 900	426
	Total	23 640	605	13 900	426
2601.12	Iron ore, agglomerated				
	United States	4 324 290	205 186	3 771 991	166 980
	Brazil	443 133	13 562	201 327	7 618
	Total	4 767 424	218 748	3 973 318	174 598
Exports					
2601.11	Iron ore concentrates, non-agglomerated				
	West Germany	2 141 792	39 340	2 238 019	46 090
	Japan	2 189 801	42 822	1 524 533	24 381
	Netherlands	1 264 509	27 756	1 414 729	25 925
	United Kingdom	1 761 022	29 211	1 225 205	25 581
	France	1 968 325	33 520	1 130 166	20 545
	Italy	687 964	14 762	375 042	8 547
	United States	870 881	23 254	317 124	6 941
	South Korea	636 094	10 534	314 469	4 778
	Belgium	439 576	7 952	309 917	5 038
	Sweden	-	-	183 133	3 744
	Portugal	172 588	3 291	134 851	2 609
	Spain	167 477	3 426	129 833	2 429
	Yugoslavia	113 168	1 656	109 976	1 814
	Brazil	-	-	55 000	2 105
	Australia	-	-	25 004	989
	Philippines	179 620	3 412	-	-
	Austria	125 495	1 803	-	-
	Pakistan	120 666	2 068	-	-
	Romania	115 058	1 776	-	-
	South Africa	75	4	-	-
	Puerto Rico	73	11	-	-
	Luxembourg	50	433	-	-
	East Germany	10	95	-	-
	Total	12 954 244	247 137	9 487 001	181 522
2601.12	Iron ore, agglomerated				
	United States	9 335 741	437 912	6 807 432	315 127
	United Kingdom	3 957 574	131 646	2 734 946	93 736
	France	793 830	24 813	718 434	22 370
	West Germany	915 635	30 014	666 564	22 315

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989p	
	(tonnes)[1]	($000)	(tonnes)[1]	($000)
Exports (cont'd)				
Italy	795 864	37 042	609 369	29 190
Netherlands	674 687	23 067	573 181	18 491
Spain	185 905	5 683	353 366	12 468
Belgium	297 646	10 888	237 132	8 851
Portugal	240 383	7 833	172 231	5 822
Japan	-	-	117 292	1 290
Yugoslavia	93 010	4 463	42 968	1 374
Venezuela	-	-	48	2
Austria	219 157	5 490	-	-
Sweden	59 746	1 899	-	-
Chile	1	59	-	-
Total	17 569 179	720 815	13 032 963	531 041
Total exports all classes				
United States	10 206 622	461 166	7 124 556	322 068
United Kingdom	5 718 596	160 857	3 960 151	119 317
West Germany	3 057 427	69 354	2 904 583	68 405
Netherlands	1 939 196	50 823	1 987 910	44 416
France	2 762 155	58 333	1 848 600	42 915
Japan	2 189 801	42 822	1 641 825	25 671
Italy	1 483 828	51 804	984 411	37 737
Spain	353 382	9 109	483 199	14 897
Belgium	737 222	18 840	547 049	13 889
South Korea	636 094	10 534	314 469	4 778
Portugal	412 971	11 124	307 082	8 431
Sweden	59 746	1 899	183 133	3 744
Yugoslavia	206 178	6 119	152 944	3 188
Brazil	-	-	55 000	2 105
Australia	-	-	25 004	989
Venezuela	-	-	48	2
Austria	344 652	7 293	-	-
Philippines	179 620	3 412	-	-
Pakistan	120 666	2 068	-	-
Romania	115 058	1 776	-	-
South Africa	75	4	-	-
Puerto Rico	73	11	-	-
Luxembourg	50	433	-	-
East Germany	10	95	-	-
Chile	1	59	-	-
Total	30 523 423	967 952	22 519 964	712 563
Consumption of iron ore at Canadian iron and steel plants	14 870 722	. .	15 820 000p	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada; American Iron Ore Association.

[1] Dry tonnes for production (shipments) by province; natural weight for imports and exports. [2] Total iron ore shipments include shipments of by-product iron ore.

p Preliminary; - Nil; x Confidential; . . Not available.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, IRON ORE PRODUCTION (SHIPMENTS), 1986-89

Company and Location	Ore Mined	Product Shipped	1986	1987	1988	1989[p]
			(000 tonnes, natural or wet)			
Adams Mine, Kirkland Lake, Ont.	Magnetite	Fluxed pellets	971	1 036	1 016	1 139
Algoma Ore Division, The Algoma Steel Corporation, Limited Wawa, Ont.	Siderite	Sinter	1 186	1 118	1 066	1 234
Iron Ore Company of Canada Schefferville, Que.	Hematite, goethite and limonite	Direct shipping	1 421[1,2]	1 173[1,2]	788[2]	177[2]
Carol Lake, Lab.	Specular hematite and magnetite	Concentrate	3 858	2 958	4 127	4 739
		Acid pellets	9 140	7 920	7 899	8 106
		Fluxed pellets	1 152	1 215	1 954	1 732
		Broken pellets	-	-	-	391
Quebec Cartier Mining Company, Mount Wright, Que.	Specular hematite	Concentrate	6 947	8 155	8 506	7 953
		Acid pellets	5 448	7 453	7 749	6 582
		Fluxed pellets	1 384	744	582	1 589
Sherman Mine, Temagami, Ont.	Magnetite	Fluxed pellets	1 036	1 090	865	1 034
Wabush Mines, Wabush, Labrador and Pointe Noire, Que.	Specular hematite and magnetite	Pellets	5 293	5 478	6 035	6 200
British Columbia Producers	Magnetite	Concentrate	51	61	59	63
Other Ontario	Magnetite	Concentrate	162	2	2	1
			38 049	38 403	40 648	40 940

[1] Includes some Carol Lake concentrate. [2] Stockpile ore.
[p] Preliminary; - Nil.

TABLE 3. RECEIPTS AND CONSUMPTION OF IRON ORE AT CANADIAN IRON AND STEEL PLANTS, AND INVENTORIES, 1988 AND 1989

	1988	Jan.-Oct. 1989
	(000 tonnes)	
Receipts imported	5 289	4 750
Receipts from domestic sources	9 490	8 381
Total receipts at iron and steel plants	14 778	13 131
Consumption of iron ore	14 871	13 183
Inventory at docks, plants, mines and furnace yards, December 31	7 489	8 091
Inventory change	644	602

Source: American Iron Ore Association.

TABLE 4. WORLD IRON ORE PRODUCTION, 1986-88

	1986	1987	1988
		(000 tonnes)	
U.S.S.R.	250 000	251 000	249 700
Brazil	129 540	134 500	145 040
Australia	97 310	105 310	99 450
People's Republic of China	142 480	157 000	154 380
India	48 820	48 420	49 420
United States	39 490	47 570	56 440
Canada	37 220	37 800	40 710
Republic of South Africa	24 480	22 000	24 680
Liberia	15 600	13 810	12 810
Sweden	20 480	19 640	20 310
Venezuela	16 720	17 200	18 220
Other countries	93 210	89 100	86 450
Total	915 350	943 350	957 610

Source: Association of Iron Ore Exporting Countries (APEF) and the Trust Fund Project on Iron Ore Information.

TABLE 5. CANADIAN CONSUMPTION OF IRON-BEARING MATERIALS BY INTEGRATED[1] IRON AND STEEL PRODUCERS, 1988

	Consumed In				
			Iron and Steel Furnaces		
Material Consumed	Sinter Plants at Steel Mill	Direct Reduction Plants	Production of Pig Iron	Steel Furnaces	Total in Furnaces
			(tonnes)		
Iron Ore					
Crude and concentrate	261 113	230 139	40 975	-	40 975
Pellets	92 288	899 790	12 174 854	2 920	12 177 774
Sinter	55 349	-	1 008 994	-	1 008 994
Sinter produced at steel plant	-	-	786 587	-	786 587
Direct reduced iron	-	-	-	746 612	746 612
Other iron-bearing materials including flue dust, mill scale, cinder, slag, etc.	406 343	-	294 985	82 051	377 036
Total	815 093	1 129 929	14 306 394	831 584	15 137 978

Source: Company data.

[1] Dofasco Inc.; Sidbec-Dosco Inc.; Sydney Steel Corporation (estimates); The Algoma Steel Corporation, Limited; Stelco Inc.

- Nil.

TABLE 6. NORTH AMERICAN PRICES OF SELECTED ORES AT YEAR-END, 1976, 1981 AND 1986-89

	1976	1981	1986	1987	1988	1989
	(US$/t)					
Mesabi Non-Bessemer[1]	19.626	31.516	29.557-31.03	29.557-31.03	29.557-31.03	29.557-31.03
Old Range Non-Bessemer and Manganiferous[1]	19.87	31.75	32.264	32.264	32.264	32.264
	(US¢ t iron unit)[2]					
PELLETS:						
Lake Erie Base Price[3]	51.476	77.95	85.53	71.31-85.53	71.31-85.53	71.31-73.47
USX Corporation[4]	-	-	-	36.756	36.756	36.756
Upper Lakes[5]	-	-	58.46	46.10-58.46	46.10-58.46	46.10-58.46
Wabush[6]	-	62.5	62.5	62.5	62.5	62.5
Mineral Services Inc.	-	-	57.09	57.09	57.09	57.09
	(US$ t)					
Direct Reduced Iron	-	-	115-135	115-135	115-135	115-135

Sources: Skillings Mining Review; Iron Age.

[1] US$/t, 51.5% of iron natural, at rail of vessel, lower lake ports. [2] One iron unit equals one percentage point of iron content in a tonne of ore; an ore containing 60% iron, therefore, has 60 iron units. [3] Cleveland-Cliffs Inc., M.A. Hanna Company, Oglebay Norton Company at rail of vessel lower lake port. [4] At mine. [5] Pickands Mather & Co. and Inland Steel Mining Co. in hold of vessel upper lake port. [6] F.o.b. Pointe Noire.

- Nil.

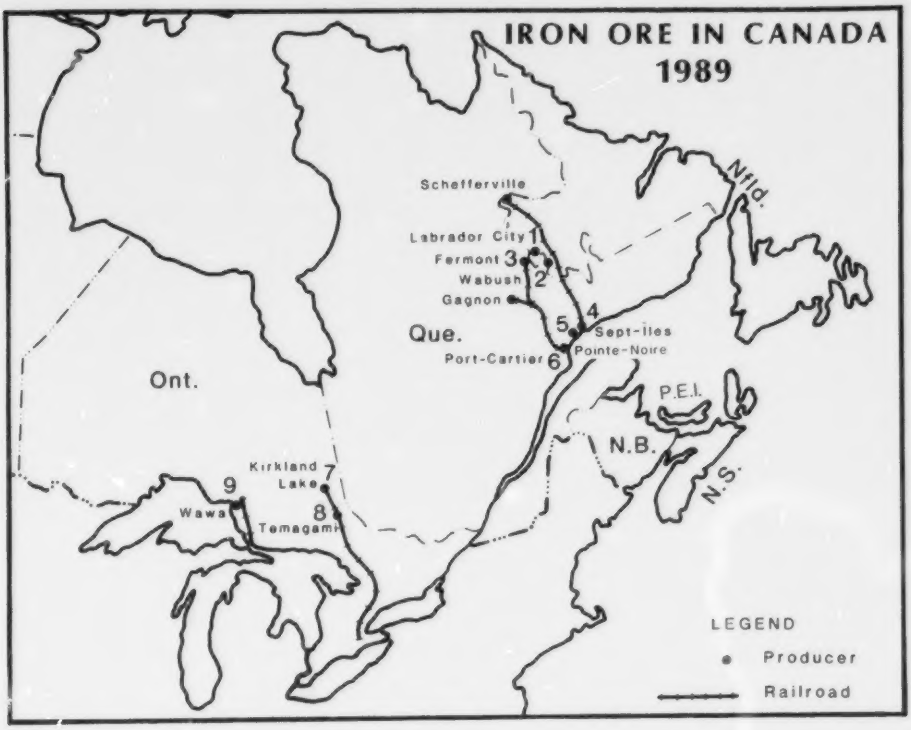
TABLE 7. SELECTED PRICES OF IRON ORE BOUND FOR JAPAN AND EUROPE 1983-89

Ore	Market	Source	1983	1984	1985	1986	1987	1988	1989
					(USc/ Fe Unit Dmt, f.o.b.)				
Fines (including concentrate)	Europe	CVRD	29.00	26.15	26.56	26.26	24.50	23.50	26.56
		Iscor	27.90	20.60	23.50	22.70	. .	20.55	. .
		Kiruna	30.10	27.70	28.50	27.90	25.25	26.00	30.00
		Carol Lake	29.30	26.80	26.80	26.50	24.03	23.685	27.00
		Mt. Wright	29.30	26.80	26.80	26.50	24.03	23.685	27.00
	Japan	CVRD	27.50	24.27	24.65	23.66	22.24	21.23	23.99
		Iscor	27.00	23.89	22.26	20.55	19.15	18.03	20.37
		Hamersley	30.50	26.67	27.05	25.97	24.67	23.68	26.76
		Carol Lake	26.70	23.37	23.37	22.44	21.26	20.25	22.88
Lump	Europe	Iscor	31.30	24.00	29.00	26.70	23.50	22.34	. .
		Hamersley[1]	38.15	36.15	38.48	36.20	33.15	36.00	43.00
	Japan	CVRD	27.90	24.27	24.65	23.66	22.24	22.24	25.60
		Iscor	30.60	27.19	25.86	23.91	22.34	22.21	26.05
		Hamersley	34.90	30.87	31.55	30.29	28.78	28.33	33.76
Pellets	Europe	CVRD	39.00	36.00	36.00	35.60	36.70	40.35	47.33
		Kiruna	41.00	38.60	38.60	38.15	41.15	46.35	53.50
		Carol Lake	. .	. .	36.50	36.50	37.15	39.95	48.35
		Mt. Wright	. .	. .	36.50	36.50	37.15	39.95	48.35
	Japan	CVRD (Nibrasco)	42.90	37.31	36.25	35.29	35.60	38.54	45.20
		Savage River	. .	38.30	37.10	36.02	34.72	36.46	42.77

Source: The Tex Report.

[1] C.i.f. Rotterdam.

. . Not available; Dmt Dry metric tonne; f.o.b. Free on board.


IRON ORE IN CANADA
1989
Schefferville
Labrador City 1
Fermont 3
Wabush 2
Gagnon
4
5
Sept-Iles
Pointe-Noire
Port-Cartier 6
Que.
Ont.
Nfld.
P.E.I.
N.B.
N.S.
Kirkland Lake 7
9
Wawa
8
Temagami
LEGEND
● Producer
Railroad

PRODUCERS
(numbers refer to numbers on map above)

1. Iron Ore Company of Canada, Carol Division (mine concentrator pellet plant)
2. Wabush Mines (mine concentrator)
3. Quebec Cartier Mining Company (mine concentrator)
4. Iron Ore Company of Canada (port)
5. Wabush Mines (pellet plant port)
6. Quebec Cartier Mining Company (pellet plant port)
7. Dofasco Inc., Adams mine (mine concentrator pellet plant)
8. Dofasco Inc., Sherman mine (mine concentrator pellet plant)
9. Algoma Ore division of The Algoma Steel Corporation, Limited (mine concentrator sinter plant)

Lead

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Western world lead consumption was estimated at 4.41 Mt in 1989, an increase of 1.2% over 1988. Metal production, including both primary and secondary material, totalled 4.39 Mt, slightly below the 4.4 Mt recorded in 1988. Total metal stocks at year-end were estimated at 390 000 t, a reduction of 48 000 t from the level reported one year earlier.

Lead prices on the London Metal Exchange (LME) rose slightly in 1989, averaging US¢30.6/lb. In 1988, the average LME price was 29.7¢.

CANADIAN DEVELOPMENTS

Canadian mine production of lead declined by 25% in 1989 to 274 000 t, compared with 366 600 t in 1988. Refined metal output fell to 246 000 t from 268 076 t.

In January, Curragh Resources Inc. was forced to declare force majeure on concentrate shipments from its Faro mine in the Yukon due to transportation problems caused by a combination of avalanches and cold weather. In July, production at Faro was interrupted when lightning strikes cut power supplies to the operation. On July 24, the company again declared force majeure on shipments after forest fires had disrupted power supplies and halted the movement of concentrates to tidewater.

In April, Curragh and Hillsborough Resources Limited purchased the Mount Hundere zinc-lead-silver property near Watson Lake, Yukon, from Canamax Resources Inc. The property is reported to contain ore reserves of 5.2 Mt grading 18.5% combined lead-zinc and 54.4 g/t silver. Production at the site, which could begin as early as 1992, is expected to provide about 30 000 t/y of lead in concentrates.

In October, Billiton Metals Canada Inc. acquired an option to earn a 50% interest in NDU Resources Ltd.'s Blende zinc-lead deposit in the Yukon. From preliminary exploration of the property conducted in 1988, the best mineralized intersection graded 5.4% lead, 3% zinc and 106.3 g/t silver. Further drilling is planned for 1990.

It was reported in May 1989 that Banco Espanol de Credito had agreed to sell a 20% interest in the Spanish lead and zinc producer Asturiana de Zinc S.A. to Curragh. As part of the agreement, Asturiana agreed to purchase a 5% interest in Curragh and a 15% share of the Cirque deposit in northern British Columbia, which could be brought on-stream as early as 1992. Development of this property, which hosts 30 Mt of reserves grading 8.6% zinc and 3.5% lead, is expected to cost $130 million. Annual lead production is expected to be about 25 000 t metal in concentrates.

In December, Cominco Ltd. completed a $260 million modernization program at its lead smelter in Trail, British Columbia. However, the company announced in January 1990 that it was experiencing start-up problems at the new facility which utilizes the QSL process. Until the new plant can be brought fully on-stream, it is expected that Cominco will continue to operate its old lead smelter at about 50% of capacity.

Cominco announced on January 17, 1990, that it was closing its Sullivan lead-zinc mine at Kimberley, British Columbia due to declining zinc prices and high production costs. The closure, which was scheduled to take effect January 31, 1990, will be for an indefinite period. The company announced that 550 of the 700 mine employees would be laid off at the end of January with the remainder of the workforce to be released in mid-February.

In addition to the higher costs associated with increasing ore depth and recent ore processing problems, the Sullivan operation experienced a significant decline in labour productivity at the end of 1989 when the existing underground bonus formula was cancelled and miners reverted to a non-incentive pay scale. During 1989, the production of lead in concentrates at the Sullivan mine fell to 64 400 t from 104 000 t in 1988. While the loss of production from the Sullivan mine, which had been one of the principal sources of feed for Cominco's lead smelter at Trail, could result in some shortage of concentrates in the short term, this deficit will gradually be eliminated as the new Red Dog mine in Alaska attains full production.

Minnova Inc. and Rea Gold Corporation officially opened their new $30.3 million Samatosum mine in British Columbia. Reserves at the property have been calculated at nearly 800 000 t grading 1.4% lead, 3.5% zinc, 1.1% copper, 833 g/t silver and 1.6 g/t gold. Annual lead production is expected to be 1000 t metal in concentrates.

In August, Regional Resources Ltd. acquired a 24.5% interest in the Midway silver-lead-zinc project from Canamax Resources Inc., thereby increasing its ownership stake to 75.5%. Current reserves at the property are estimated at 1.185 Mt grading 410 g/t silver, 7% lead and 9.6% zinc. Additional exploration of the property is planned for 1990.

In Manitoba, Hudson Bay Mining and Smelting Co., Limited (HBMS) completed an expansion program at its Chisel Lake mine. It is expected that the expansion will increase lead output by about 5000 t/y.

Mine production fell at Brunswick Mining and Smelting Corporation Limited's operations in New Brunswick, principally due to a cutback in hoisting capacity resulting from work to deepen the No. 3 shaft at the Brunswick 12 mine. Some stockpiled ore was treated, which partially compensated for the reduction in mine output. In May, smelter output was affected by a seven-day shutdown of the sinter and acid plants.

After failing to meet its initial production target, East West Caribou Mining Limited suspended production at its Caribou mine in New Brunswick in July, after only seven months of operation. However, the company planned to develop additional ore reserves and resume mining operations in early 1990. Reserves at the Caribou property are estimated at 15 Mt grading 11% combined lead and zinc.

In August, Noranda Inc. and Brunswick Mining and Smelting re-opened the Heath Steele mine near Bathurst, New Brunswick. Production at the mine had been suspended in 1983 due to low metal prices. The Heath Steele property, which includes three separate orebodies, contains reserves totalling 4 Mt with a grade of 6.3% zinc, 2.5% lead, 0.7% copper and 70 g/t silver.

Also in New Brunswick, Marshall Minerals Corp. continued work on its Restigouche property in the northern part of the province. It was reported that Marshall had reached an agreement with East West Caribou Mining whereby the latter would process ore from the Restigouche mine. Reserves at the site have been calculated at about 1.1 Mt grading 0.35% copper, 5.96% lead, 7.71% zinc, 124 g/t silver and 1.2 g/t gold.

In Nova Scotia, Westminer Canada Limited plans to reactivate its Gays River mine in 1990. The mine, which was developed by Esso Minerals Canada, operated from 1979 to 1982. The Gays River mill, which was converted to treat gold ore, will be reconverted to process lead-zinc ore. It is expected that the operation will initially produce about 10 000 t/y lead and 15 000 t/y zinc in concentrates. Reserves at the Gays River property are about 1.5 Mt grading 10% zinc and 6.2% lead.

WORLD DEVELOPMENTS

According to the International Lead and Zinc Study Group (ILZSG), non-socialist world lead mine production decreased slightly in 1989 to 2.326 Mt from 2.338 Mt in 1988. The United States and Peru recorded the largest increases in output while Canada posted the largest production decline. Although Peruvian production did improve over 1988 levels, its output was signifi-cantly below that achieved in 1987 due to con-tinuing labour problems and guerrilla attacks.

Cominco Ltd.'s Red Dog mine in Alaska began production late in 1989, with a 1990 production target of about 49 000 t lead in concentrate. The Red Dog property hosts reserves of 77 Mt grading 17.1% zinc, 5.0% lead and 82 g/t silver. At full design capacity, annual output at the Red Dog operation is expected to total 65 000 t lead and 325 000 t zinc in concentrates.

The Green's Creek joint venture project on Admiralty Island off Alaska began production early in the year. The project, owned 53% by RTZ Corporation PLC, 28% by Hecla Mining Company, 12.6% by CSX Corporation and 6.3% by Exalas Resources Inc., is expected to produce 10 000 t/y lead in concentrate.

The Doe Run Company re-opened the Brushy Creek mine and mill in Missouri. This operation was closed in 1984 when the company was forced to rationalize production because of low lead prices. It is expected that output will be about 11 000 t/y lead in concentrate.

At the end of 1989, it was reported that Plumbum SA Mineracao e Metalurgia, Brazil's only lead producer, was forced to close due to failure to reduce toxic emissions. The smelter has an installed lead capacity of 19 000 t/y. Also in Brazil, Cia. Paraibuna de Metais SA will build a new 45 000 t/y lead smelter that will utilize QSL technology. Concentrate requirements for this plant will be imported, most likely from Peru.

In Bolivia, Corporacion Minera de Bolivia (Comibol) plans to reactivate its Bolivar lead-tin-zinc-silver mine by the end of 1990. The mine is expected to produce about 3000 t/y lead in concentrates.

In Australia, M.I.M. Holdings Limited announced plans to go ahead with the construction of a new 60 000 t/y lead smelter at its Mt. Isa operations. The new smelter will use the innovative Isasmelt technology, a form of direct smelting. Total lead bullion output is expected to reach 210 000 t/y when the new facility is commissioned in 1990.

Also in Australia, it was reported that the Thalanga polymetallic mine project in Queensland could come on-stream in 1990. The mine, which is a joint venture between Pancontinental Mining Ltd., Outokumpu Oy and Agip Australia Pty, is expected to initially produce 4000 t/y lead in concentrate, eventually increasing to 13 000 t/y. The joint venture partners are also considering development of their Lady Loretta property in Queensland, which would produce up to 26 000 t/y lead in concentrates.

In India, Hindustan Zinc Ltd. is proceeding with the construction of a new primary lead smelter at Chanderiya. The plant, which will have a capacity of 35 000 t/y, is expected to come on-stream in 1991.

Boliden Mineral AB announced the discovery of a 50 Mt deposit with combined lead-zinc grades of 14% near its Aznalcollar mine in Spain. This deposit could replace the Aznalcollar mine which will be exhausted in 1992.

In the United Kingdom, Anglesey Mining Co. Ltd. is developing its Parys Mountain lead-zinc deposit in north Wales. It is expected that production will begin in 1990, although the operation will not attain its full design capacity of about 12 000 t/y lead in concentrate for several years.

In August, a failure in the control system of Nuova Samim, SpA's lead smelter at Porto Vesme in Sardinia, forced the closure of the plant. The company expected to have the 84 000 t/y plant back on-stream in the first quarter of 1990.

RECYCLING

Standard Industries of San Antonio, Texas, closed its 12 000 t/y secondary lead smelter due to environmental problems. The company's battery plant will remain open.

In the United States, Exide-General Corp. re-opened its Muncie, Indiana secondary smelter. Although the facility will initially operate at an annual rate of 45 000 t, the company may increase production to the plant's designed capacity of 68 000 t/y in order to replace output from the 22 800 t/y Dallas lead plant, which was scheduled to close in December 1989.

The Doe Run Company announced that it was considering the conversion of part of its idled Buick primary smelter in Boss, Missouri into a secondary production facility. Capacity of this plant would be approximately 54 000 t/y.

In the United Kingdom, Britannia Refined Metals Ltd. (BRM), a subsidiary of M.I.M. Holdings Limited of Australia, was reported to have purchased a 30 000 t/y lead recycling plant at Wakefield in Yorkshire from Chloride Metals. In addition, BRM plans to build a new 40 000 t/y smelter at its Northfleet operations in Kent. The new smelter, which will be completed in 1991, will utilize Isasmelt technology.

In Ontario, Tonolli Canada Ltd. is increasing its secondary lead production capacity from 32 000 t/y to 40 000 t/y through the installation of an electrowinning process patented by Engitec Impianti of Italy. The new process, combined with a new desulphurization plant, will mean that virtually all components contained in a spent battery will be recycled. The sulphur will be sold as a sodium sulphate for detergents.

CONSUMPTION AND USES

On the basis of preliminary statistics from ILZSG, lead consumption in 1989 increased to a record 4.406 Mt. Consumption in 1988 was 4.353 Mt.

Lead is a dense bluish-white metal whose physical and chemical properties find application in a variety of uses in the manufacturing, construction and chemical industries.

Lead acid batteries constitute the largest market for lead, representing over 60% of total non-socialist usage. In the United States, battery manufacturing constitutes almost 80% of total lead demand. The largest single battery market, representing about 80% of lead used in the industry, is in the automotive sector. The average automobile battery contains about 10 kg of lead. A potential growth area for the lead acid battery is in energy storage facilities for utilities. These are designed to supplement existing generators during the peak morning and evening hours without drawing on other sources or building new power plants.

The use of lead in chemicals and compounds constitutes the second largest use of the metal. The principal uses are in PVC stabilizers, which prevent degradation during processing or from ultraviolet radiation; colour pigments; and the manufacture of glass, including crystal, light bulbs, insulators and television/computer screens. While lead is still used for some specific paint applications, its general use has declined significantly due to the potential risk involved in exposure to weathered or flaked paint.

Until the mid-1970s, the production of lead additives for gasoline, including tetraethyl lead, constituted one of the most important markets for the metal. However, with the adoption of environmental regulations that have either prohibited or severely restricted the use of such additives, the demand for lead has declined dramatically. In the United States, it is expected that the demand for lead additives in agricultural vehicles and in aviation will continue, but that this will level off at about 2250 t/y of contained lead.

Lead is alloyed with tin in the production of solder used in both the electronics and plumbing sectors, although these markets have declined in recent years. In the plumbing industry, the demand for lead has fallen as a result of the increasing use of plastic piping. Where metal systems are still used for potable water systems, new regulations, which have been adopted or are being considered, will reduce the amount of lead in solder. In the electronics field, the move to miniaturization combined with the replacement of printed circuit boards have reduced the demand for lead.

Other important applications of both lead metal and lead alloys include: the production of free machining steel and brass, rolled sheet and strip for roofing applications, power and communication cable sheathing, especially for underground or submarine environments, and as a sound barrier material in construction.

Lead's high resistance to gamma radiation and X-rays makes it the preferred metal for shielding around X-ray equipment and at nuclear installations.

MARKETS, PRICES AND STOCKS

Lead prices on the London Metal Exchange (LME) averaged US¢30.6 /lb. in 1989, up slightly from 29.7¢ in 1988. The U.S. domestic lead price was also higher at 39¢, compared with 37¢ in 1988. Table 3 provides a detailed price history for both price quotes.

LME prices, which averaged US¢32.1 in January 1990, increased dramatically at the end of February reaching 60¢ in mid-March. This increase was attributed to a combination of strong demand, relatively low stock levels and production problems at several lead smelters.

According to the latest statistics compiled by the ILZSG, lead stocks totalled 390 000 t at the end of 1989 compared with 438 000 t one year earlier. The stocks were held as follows: 185 000 t by producers, 180 000 t by consumers, 2000 t by merchants and 23 000 t by the LME.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group was formed in 1959 to improve market information and to provide opportunities for regular inter-governmental consultations on lead and zinc markets. Particular attention is given to providing regular and frequent information on supply and demand and its probable development. The Group celebrated its 30th anniversary in 1989.

The Study Group is headquartered in London, England. Its membership includes most major lead- and zinc-producing and consuming countries. While it has an extensive information gathering and dissemination role, the Group has no market intervention powers. Member countries' delegations generally include industry representatives as advisors. It is noteworthy that the People's Republic of China joined the organization in 1987, as well as the Republic of Korea. Canada has been an active member since its inception and chaired the Group in 1988 and 1989.

HEALTH, SAFETY AND THE ENVIRONMENT

In response to concern over the health effects of exposure to lead and lead compounds, and to an overall increase of environmental awareness, governments in the industrialized nations have moved to restrict or ban the use of lead additives in gasoline. In addition to the potential benefits associated with the removal of lead emissions, the use of unleaded fuel permits the removal of hydrocarbons, carbon monoxide and nitrous oxides from automobile exhaust gases. In Canada, leaded gasoline will be phased out before the end of 1990.

The International Lead-Zinc Research Organization (ILZRO) has established a Lead and Cancer Task Force to undertake a program of re-search into lead carcinogenicity and specifically to develop the critical information required for the establishment of acceptable exposure limits related to lead. The task force has developed a multi-project plan calling for expenditures on various scientific studies costing $2.76 million over three years.

In the United States, growing concern for the environment has resulted in the adoption of battery recycling laws in various parts of the country aimed at reducing the number of used batteries deposited in landfill sites. This includes the application of a surcharge on new batteries sold which is later refunded when the spent battery is returned.

According to press reports based on an internal lead pollution study by the U.S. Environmental Protection Agency, that body is considering a number of new regulations that would have far-ranging implications for the entire U.S. lead industry. This includes the establishment of a system of permits to limit the mining or importation of the metal, along with the requirement that battery manufacturers use some secondary material in their production processes. In addition, the report proposes that: used batteries be sent to designated collection points, the production of replacement batteries be linked to the number of batteries recycled, and battery manufacturers or retailers offer inducements to consumers that would promote the collection and recycling of used batteries. The report also stated that all of the primary lead smelters in the United States and most of the secondary plants did not meet National Ambient Air Quality Standards.

OUTLOOK

With the prospect of relatively steady demand combined with the possibility of supply disruptions caused by technical problems or labour disruptions at primary lead smelters, it is expected that lead prices in 1990 will be slightly above 1989 levels.

Despite the fact that lead demand is expected to grow at an average annual rate of about 1.5% through the 1990s, the medium-to-longer-term outlook is for prices in the mid to upper US¢20/lb. range (constant dollar terms). This weakness is expected to occur as a result of a dramatic increase in both mine production and the recovery of lead scrap.

With the start-up in the early 1990s of a number of new lead-zinc operations, particularly in North America and Australia, it is expected that primary lead output will increase by at least 350 000 t/y. With the adoption of additional regulations that will require greater recycling, it is expected that secondary production will increase by up to 400 000 t/y by 1995.

Note: Information contained in this review was current as of mid-January 1990.

TARIFFS

		Canada			United States	EEC	Japan[1]
Item No.	Description	MFN	GPT	USA	Canada[1]	MFN	MFN
2607.00.00	Lead ores and concentrates	Free	Free	Free	1.5¢/kg on Pb	Free	Free
78.01	Unwrought lead						
7801.10	- Refined lead						
7801.10.10	--- Pig and block	Free	Free	Free	2.7% on Pb	3.5%	8 yen/kg
7801.10.90	--- Other	10.2%	Free	8.1%	2.7% on Pb	3.5%	8 yen/kg
	- Other						
7801.91	-- Containing by weight antimony as the principal other element						
7801.91.10	--- Lead antimony - tin alloys	6.8%	Free	5.4%	2.7% on Pb	3.5%	6.5%
7801.91.90	--- Other	10.2%	Free	8.1%	2.7% on Pb	3.5%	6.5%
7801.99	-- Other						
7801.99.10	--- For refining, containing 0.02% or more by weight of silver (bullion lead)	10.2%	Free	8.1%	3.1% on Pb	Free	6%
7801.99.91	---- Lead alloys	10.2%	Free	8.1%	2.7% on Pb	3.5%	6%
7801.99.99	---- Other	10.2%	Free	8.1%	2.7% on Pb	3.5%	8 yen/kg
7802.00.00	Lead waste and scrap	Free	Free	Free	Free	Free	3.2%
7804.20	- Powders and flakes						
7804.20.10	--- Powders, not alloyed	4%	Free	3.2%	10.1%	2.2%	6.5%
7804.20.20	--- Alloyed powders; flakes	10.2%	Free	8.1%	10.1%	2.2%	6.5%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Customs Tariff Schedules of Japan, 1989.

[1] GATT rate is shown, lower tariff rates may apply circumstantially.

TABLE 1. CANADA, LEAD PRODUCTION AND TRADE, 1988 AND 1989, AND CONSUMPTION, 1987 AND 1988

		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Shipments					
All forms[1]					
Newfoundland		-	-	-	-
Prince Edward Island		-	-	-	-
Nova Scotia		-	-	-	-
New Brunswick		74 543	75 587	68 356	71 227
Quebec		-	-	-	-
Ontario		2 485	2 520	x	x
Manitoba		457	463	1 870	1 948
Saskatchewan		-	-	-	-
Alberta		-	-	-	-
British Columbia		105 103	106 575	72 163	75 194
Yukon		117 058	118 696	x	x
Northwest Territories		51 502	52 223	37 426	38 998
Total		351 148	356 064	275 800	287 383
Mine output[2]		366 564	..	274 136	..
Refined production[3]		268 076	..	246 000	..
Exports				(Jan. - Sept.)	
2607.00	Lead in ores and concentrates				
	Japan	57 968	18 771	42 513	13 091
	Italy	30 002	15 539	15 770	9 456
	South Korea	10 440	5 325	12 593	7 868
	Belgium	27 313	11 662	10 186	6 273
	West Germany	16 633	7 727	8 124	4 656
	Morocco	-	-	5 436	2 846
	India	-	-	2 921	1 529
	United States	4 781	2 685	2 586	2 445
	Australia	22 357	12 558	2	4
	Total	169 494	74 270	100 132	48 171
2608.00	Zinc ores and concentrates				
2608.00.20	----- Lead content	35 045	13 707	11 436	3 691
78.01	Unwrought lead				
7801.10	- Refined lead				
	United States	95 537	87 396	24 130	22 239
	People's Republic of China	1 416	1 064	19 242	14 751
	United Kingdom	39 844	30 604	13 900	8 634
	Netherlands	5 886	5 600	8 930	7 993
	Korea, South	7 603	5 576	5 699	4 541
	Italy	4 666	4 577	4 892	5 000
	Japan	3 313	2 590	3 846	3 172
	Other countries	17 722	15189	9 008	7 715
	Total	175 987	152 603	89 648	74 054

TABLE 1. (cont'd)

		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
7801.91	-- Containing by weight antimony as the principal other element	12 813	12 371	2 821	1 820
7801.99	-- Other	10 788	10 744	6 896	7 431
7802.00	Lead waste and scrap				
	Brazil	289	96	4 958	1 399
	United States	3 151	1 413	3 905	1 102
	Philippines	-	-	568	177
	Other countries	5 775	1 754	1 620	935
	Total	9 214	3 267	11 051	3 618
7803.00	Lead bars, rods, profiles and wire				
	United States	310	576	1 914	1 608
	Other countries	17	64	12	46
	Total	327	642	1 927	1 656
78.04	Lead plates, sheets, strip and foil; lead powders and flakes				
	- Plates sheets, strip and foil				
7804.11	-- Sheets, strip and foil of a thickness (excluding any backing) <0.2 mm	22	28	60	107
7804.19	-- Other	3 478	1 722	5 572	2 517
7804.20	- Powders and flakes	133	256	1 892	473
7805.00	Lead tubes, pipes and tube or pipe fittings (i.e., couplings, elbows, sleeves)	7	20	15	90
7806.00	Other articles of lead				
	Brazil	. .	402	. .	1 196
	United States	. .	1 261	. .	985
	India	. .	-	. .	638
	Other countries	. .	147	. .	191
	Total	. .	1 814	. .	3 023
Imports					
2607.00	Lead ores and concentrates				
	United States	8 683	15 066	7 870	11 308
	Peru	4 745	52 739	6 941	30 787
	Australia	2 260	1 812	3 408	3 266
	Honduras	-	-	3 018	5 239
	Italy	2	776	1 920	1 010
	Bolivia	27	605	-	-
	Other countries	-	-	1	-
	Total	15 718	71 001	23 157	51 612

TABLE 1. (cont'd)

		1988		Jan.-Sept. 1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
2608.00.00	Zinc ores and concentrates				
2608.00.00.20	----- Lead content	735	375	593	343
78.01	Unwrought lead				
7801.10	- Refined lead				
7801.10.10.00	--- Pig and block	13 565	12 704	9 015	8 414
7801.10.90.00	--- Other	289	337	19	32
7801.91	--- Containing by weight antimony as the principal other element	78	123	178	245
7801.99	-- Other	878	832	49	52
7802.00	Lead waste and scrap				
	United States	36 352	14 087	20 801	9 062
	Poland	-	-	396	277
	Italy	-	-	35	510
	Other countries	389	245	21	8
	Total	36 741	14 334	21 254	9 859
7803.00	Lead bars, rods, profiles and wire				
	United States	280	402	-	-
	Other countries	28	31	124	179
	Total	308	434	124	179
78.04	Lead plates, sheets, strip and foil; lead powders and flakes				
	- Plates, sheets, strip and foil				
7804.11	-- Sheets, strip and foil of a thickness (excluding any backing) <0.2 mm	223	347	118	204
7804.19	-- Other	778	763	308	469
7804.20	- Powders and flakes	10	16	59	83
7805.00	Lead tubes, pipes and tube or pipe fittings (i.e., couplings, elbows, sleeves)	65	128	11	26
7806.00	Other articles of lead				
	United States	..	2 776	..	1 753
	Japan	..	124	..	-
	West Germany	..	86	..	-
	Other countries	..	132	..	142
	Total	..	3 124	..	1 895

TABLE 1. (cont'd)

	1987			1988p		
	Primary	Secondary[5]	Total	Primary	Secondary[5]	Total
	(tonnes)					
Consumption[4]						
Lead used for, or in the production of:						
Antimonial lead	x	22 323	x	x	22 916	x
Batteries and battery oxides	26 993	11 077	38 070	25 352	9 394	34 746
Chemical uses: white lead, red lead, litharge, tetraethyl lead, etc.	13 676	x	x	14 357	x	x
Copper alloys: brass, bronze, etc.	480	45	525	305	x	x
Lead alloys:						
solders	966	1 767	2 733	921	1 333	2 254
others (including babbitt, type metals, etc.)	x	x	3 642	x	x	4 414
Semi-finished products:						
pipe, sheet, traps, bends, blocks for caulking, ammunition, etc.	920	819	1 739	2 199	903	3 102
Other lead products	5 733	5 271	11 004	4 143	1 143	5 286
Total, all categories	51 667	47 138	98 805	50 044	40 408	90 452

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Production includes recoverable lead in ores and concentrates shipped, valued at the average Montreal price for the year. [2] Lead content of domestic ores and concentrates exported. [3] Primary refined lead from all sources. [4] Available data, as reported by consumers. [5] Includes all remelt scrap lead used to make antimonial lead.

p Preliminary; - Nil; . . Not available; x Confidential.

TABLE 2. CANADA, LEAD PRODUCTION, TRADE[1] AND CONSUMPTION, 1970, 1975, 1980, AND 1982–89

	Production		Exports[1]				
	All forms[2]	Refined[3]	In ores and concentrates	Refined	Total	Imports refined	Consumption[5]
				(tonnes)			
1970	353 063	185 637	186 219	138 637	324 856	1 995[4]	85 360
1975	349 133	171 516	211 909	110 882	322 791	1 962[4]	89 192
1980	251 627	162 463	147 008	126 539	273 547	2 602[4]	106 836
1982	272 187	174 310	106 744	146 130	252 874	5 661[4]	103 056
1983	271 961	178 043	85 459	147 263	232 722	2 550[4]	88 579
1984	264 301	174 987	114 720	124 149	238 869	6 313[4]	111 642
1985	268 291	173 220	93 657	113 993	207 650	5 675[4]	104 447
1986	334 342	169 934	118 373	111 831	230 204	4 247[4]	94 680
1987	373 215	230 661	207 936	100 204	308 140	12 558[4]	99 805
1988	351 148	268 076	204 540	179 946	384 486	15 173	90 452[p]
1989[p]	275 800	246 000	111 568[6]	99 099[6]	210 667[6]	9 642[6]	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Beginning in 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include H.S. classes 2607.00 and 2608.00.20. Refined exports include H.S. classes 7801.10, 7803.00, 7804.11, 7804.19 and 7804.20. Refined imports include H.S. classes 7801.10.10.00, 7801.10.90.00, 7803.00, 7804.11, 7804.19 and 7804.20. [2] Recoverable lead in ores and concentrates shipped. [3] Primary refined lead from all sources. [4] Lead in pigs, blocks and shot. [5] Consumption of lead, primary and secondary in origin, as measured by survey of consumers. [6] January to September 1989.
[p] Preliminary; . . Not available.

TABLE 3. AVERAGE ANNUAL LEAD PRICES 1975-89

Year	London Metal Exchange				
	Settlement		3 Months		U.S. Domestic
	(£/t)	(USc/lb.)	(£/t)	(USc/lb.)	(USc/lb.)
1975	185.63	18.755	186.78	18.821	21.529
1976	250.70	20.480	259.79	21.275	23.102
1977	354.11	28.022	359.12	28.433	30.703
1978	342.79	29.886	342.94	29.895	33.653
1979	567.66	54.574	542.66	52.161	52.642
1980	391.29	41.237	392.08	41.343	42.455
1981	363.37	33.327	370.93	34.025	36.531
1982	310.72	24.679	321.55	25.516	25.547
1983	270.97	19.290	290.62	19.983	21.377
1984	332.49	20.156	333.20	20.196	25.548
1985	304.01	17.876	304.03	17.877	19.067
1986	277.36	18.456	277.61	18.473	22.047
1987	363.66	27.098	346.40	25.736	35.943
1988	368.40	29.748	358.35	28.834	37.140
1989	412.39	30.669	406.41	29.908	39.350

Sources: London Metal Exchange; Metals Week.

TABLE 4. AVERAGE MONTHLY LEAD PRICES 1988 AND 1989

	London Metal Exchange					
	Settlement		3 Months		U.S. Domestic	
	(£/t)	(USc/lb.)	(£/t)	(USc/lb.)	(Cc/lb.)	(USc/lb.)
1988						
January	370.20	30.247	349.84	28.583	51.5	40.1
February	372.95	29.743	346.29	27.617	45.8	36.1
March	353.89	29.267	335.15	27.717	44.3	35.5
April	345.74	29.455	331.63	28.253	43.9	35.5
May	357.50	30.314	336.41	28.523	43.8	35.4
June	381.30	30.731	364.51	29.377	43.2	35.6
July	363.17	28.089	363.32	28.100	43.5	36.0
August	354.48	27.285	358.02	27.558	44.0	36.0
September	362.11	27.659	367.05	28.037	45.8	37.3
October	376.81	29.673	377.29	29.711	47.4	39.3
November	382.27	31.359	378.76	30.071	49.7	40.8
December	400.35	33.156	391.95	32.461	49.3	41.2
1989						
January	380.95	30.650	381.36	30.465	48.2	40.5
February	354.54	28.197	359.62	28.377	45.7	38.4
March	343.66	26.725	352.15	27.206	44.8	37.5
April	367.52	27.582	360.34	27.611	44.6	37.5
May	394.57	29.186	384.99	28.290	43.5	36.5
June	426.93	30.215	406.67	28.338	45.4	37.9
July	424.46	31.322	425.10	31.369	46.1	38.8
August	440.43	31.856	431.76	30.857	46.5	39.5
September	463.33	33.027	456.65	32.162	47.9	40.5
October	473.59	34.101	464.68	32.983	47.6	40.5
November	440.55	31.424	436.21	30.615	47.4	40.5
December	445.29	32.252	434.71	30.970	45.9	39.5

Source: Metals Week.

TABLE 5. NON-SOCIALIST WORLD LEAD CONSUMPTION 1985-88

	1985		1986		1987		1988[1]	
	(000 t)	(%)	(000 t)	(%)	(000 t)	(%)	(000 t)	(%)
Batteries	2 125.8	58.0	2 171.2	59.7	2 312.3	60.5	1 744	62.7
Cable sheathing	211.6	5.8	199.8	5.5	193.1	5.1	62	2.2
Rolled and extruded products	277.8	7.6	284.4	7.8	289.0	7.6	226	8.1
Shot/ammunition	101.8	2.8	92.0	2.5	87.7	2.3	64	2.3
Alloys	154.1	4.2	142.1	3.9	148.4	3.9	117	4.2
Pigments and other compounds	507.4	13.9	492.3	13.5	517.4	13.5	405	14.6
Gasoline additives	136.3	3.7	110.3	3.1	106.4	2.8	17	0.6
Miscellaneous	148.0	4.0	145.7	4.0	169.1	4.3	146	5.3
Total	3 662.5	100.0	3 637.8	100.0	3 823.4	100.0	2 781	100.0

Source: International Lead and Zinc Study Group.

[1] 1988 statistics are for: Australia, Canada, France, the Federal Republic of Germany, Japan, Mexico, the United Kingdom and the United States.

TABLE 6. REFINED LEAD CONSUMPTION BY COUNTRY 1985–89

	1985	1986	1987	1988	1989
			(000 t)		
Canada	104	95	103	102	100
United States	1 124	1 134	1 217	1 236	1 245
Mexico	125	103	100	77	85
Brazil	73	92	93	95	96
Other America	84	93	95	85	82
Total America	1 510	1 517	1 608	1 595	1 608
United Kingdom	274	282	288	303	308
Federal Republic of Germany	346	359	345	373	370
Italy	235	238	244	246	252
France	208	205	207	216	222
Spain	116	112	128	123	125
Other EEC	183	196	187	184	180
Other Europe	252	269	253	256	259
Total Europe	1 614	1 661	1 652	1 701	1 713
Japan	397	389	378	406	403
Republic of Korea	81	88	122	146	186
China	40	59	75	75	75
India	72	77	70	75	80
Other Asia	145	154	165	175	150
Total Asia	735	767	810	877	894
Australia	59	60	62	60	63
Other Oceania	10	8	8	9	9
Total Oceania	69	68	70	69	72
South Africa	48	49	51	56	62
Egypt	14	13	16	10	11
Algeria	14	21	19	21	20
Other Africa	22	21	23	24	26
Total Africa	98	104	109	111	119
Total Non-socialist World	4 026	4 117	4 249	4 353	4 406

Source: International Lead and Zinc Study Group.

TABLE 7. LEAD MINE PRODUCTION BY COUNTRY 1985–89

	1985	1986	1987	1988	1989
			(000 t)		
Canada	285	349	414	367	273
United States	424	353	318	394	434
Mexico	203	195	177	171	175
Peru	210	194	204	149	180
Other America	77	60	55	64	89
Total America	1 198	1 151	1 168	1 145	1 151
Yugoslavia	115	103	94	95	89
Sweden	76	89	89	85	82
Spain	87	82	82	74	70
Ireland	35	36	34	33	34
Federal Republic of Germany	26	22	25	18	10
Other EEC	61	52	56	69	65
Other Europe	12	10	10	7	7
Total Europe	412	394	390	381	357
Japan	50	40	28	23	19
Iran	21	20	20	30	30
Thailand	29	30	34	29	26
India	26	25	29	23	23
Other Asia	29	40	28	31	31
Total Asia	155	155	139	136	129
Australia	474	418	455	457	481
South Africa	123	125	123	122	113
Morocco	107	73	72	69	67
Zambia	23	24	23	21	20
Other Africa	7	8	6	7	8
Total Africa	260	230	224	219	208
Total Non-socialist World	2 499	2 348	2 376	2 338	2 326

Source: International Lead and Zinc Study Group.

TABLE 8. REFINED LEAD PRODUCTION BY COUNTRY 1985–89

	1985	1986	1987	1988	1989
			(000 t)		
Canada	240	258	231	268	246
United States	1 054	932	1 042	1 091	1 146
Mexico	203	185	185	179	172
Brazil	73	85	88	98	90
Peru	83	66	71	54	70
Other America	55	56	56	48	34
Total America	1 708	1 582	1 673	1 738	1 758
United Kingdom	327	329	347	374	368
Federal Republic of Germany	356	367	341	345	344
Italy	140	132	168	168	205
France	224	231	246	256	265
Spain	168	130	126	122	128
Yugoslavia	123	138	128	131	130
Other EEC	173	161	150	178	91
Other Europe	102	107	116	109	96
Total Europe	1 613	1 595	1 622	1 683	1 627
Japan	367	362	339	340	332
Republic of Korea	36	60	83	90	106
China	49	54	66	67	70
India	24	29	32	32	38
Other Asia	63	60	64	73	80
Total Asia	539	565	584	602	626
Australia	216	171	217	204	215
Other Oceania	4	4	4	5	5
Total Oceania	220	175	221	209	220
South Africa	75	70	75	81	77
Morocco	63	55	62	71	65
Zambia	10	7	9	8	4
Other Africa	11	13	8	7	9
Total Africa	159	145	154	167	155
Total Non-socialist World	4 239	4 062	4 254	4 399	4 386

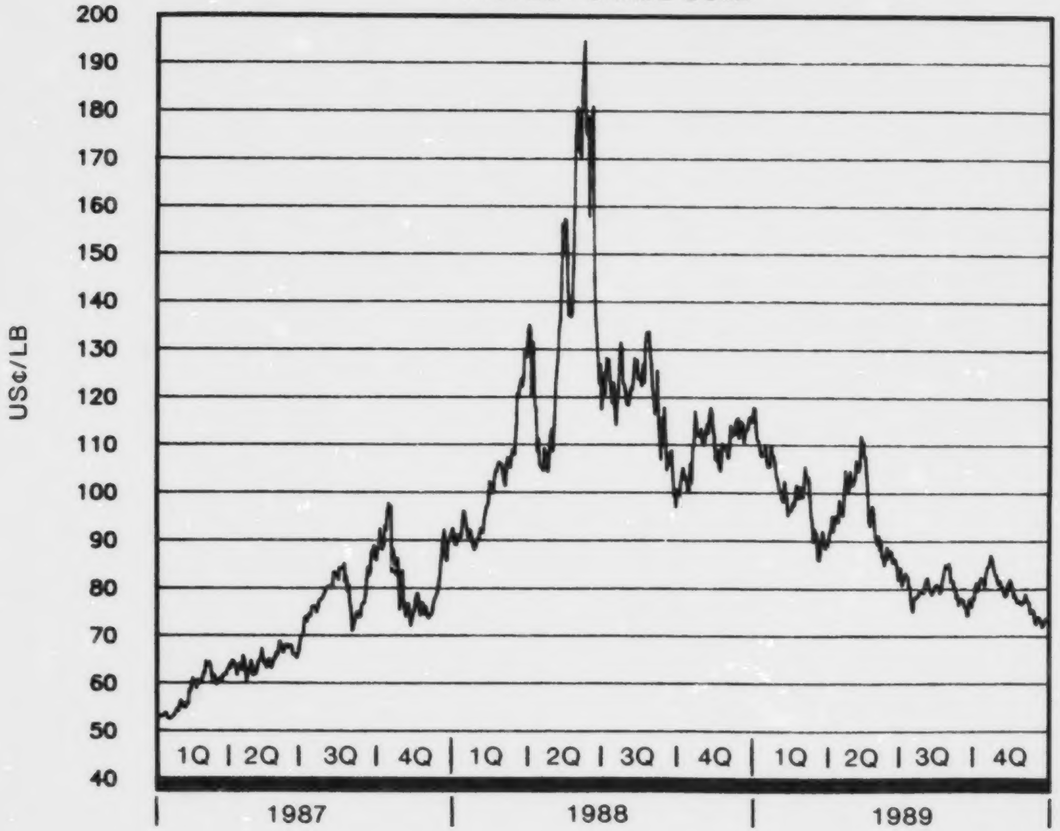
Source: International Lead and Zinc Study Group

TABLE 9. CANADA, PRIMARY LEAD REFINED METAL CAPACITY, 1989

Company and Location	Annual Rated Capacity
	(000 tonnes of refined lead)
Brunswick Mining and Smelting Corporation Limited Belledune, New Brunswick	72
Cominco Ltd. Trail, British Columbia	160
Canada, Total	232

LONDON METAL EXCHANGE ALUMINUM PRICES

HIGHEST GRADE SOLD



Magnesium 1989

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Production start-up at the Norsk Hydro Canada Inc. plant in Bécancour and at the Magnesium Company of Canada Ltd. (MAGCAN) plant will increase Canadian production capacity for metallic magnesium from its present level of 5000 t/y to nearly 60 000 t/y, making Canada the second largest magnesium producer in the world after the United States. If projected growth rates for the metallic magnesium market materialize, Canadian production could easily double over the next five years.

In 1989, world shipments of magnesium stood at 246 200 t, a decrease of almost 2% compared with the total recorded for 1988. Production increased by over 10 000 t compared with the 1988 total, reaching 252 800 t. This difference between shipments and production made it possible to increase inventories by 6000 t between December 1988 and December 1989, bringing the total to 34 800 t.

CANADA

Canadian magnesium consumption stood at 13 224 t in 1988, a sharp increase from the 9469 t consumed in 1987. This upward trend should continue over the next three years, primarily in the aluminum alloys sector because of construction and expansion projects under way in Canadian aluminum plants. These projects could lead to production increases of approximately 700 000 t/y of aluminum by 1993. Canadian consumption of magnesium used in aluminum alloys may increase by more than 3000 t/y over the next three years. In the same period, strong growth is expected in the die-casting of magnesium parts for the automobile industry.

Timminco Limited, for many years Canada's only producer of magnesium, continued its planned rationalization in 1989 at its Haley plant through the construction of a new prototype magnesium vacuum-smelting furnace and the installation of an automatic system for operating the furnace roof. As a result of this rationalization process, production capacity was reduced from 9000 t/y to 5000 t/y, and the number of employees declined from 450 to 225.

Timminco produces high-purity magnesium (up to 99.95% pure) for specialized market applications. In 1989, its magnesium was used in such applications as alloys with aluminum and calcium, Grignard reagents for the pharmaceutical industry and electronic products. Timminco also produces metallic calcium and strontium, and has set up a research and development team to develop new applications for these specialized metals.

In December 1989, Norsk Hydro Canada Inc. made its first delivery of metallic magnesium from its plant in Bécancour. The Bécancour plant should reach its full production capacity of 40 000 t/y by the end of the first quarter of 1990 and is expected to employ 350 permanent workers. Production capacity could be increased to 60 000 t/y at a cost of about $75 million. The plant has been designed to allow expansions of up to 240 000 t.

In November 1989, Norsk indicated that it had exceeded the initial construction cost estimate of $400 million by between $150 million and $200 million. In order to meet Government of Quebec environmental standards for dioxin emissions, the Norwegian company had to build an underground effluent collection tunnel and secondary treatment facilities at a cost of about $50 million.

The Bécancour plant receives its magnesite supply from China. At the current production rate of 40 000 t/y, it is estimated that magnesite consumption in Bécancour will be 160 000 t/y. The process technology used at the Bécancour plant involves leaching the magnesite with hydrochloric acid to produce a brine of magnesium chloride ($MgCl_2$), and then reducing the $MgCl_2$ granules in electrolytic cells to produce metallic magnesium.

In Alberta, MAGCAN continued construction of its metallic magnesium plant in Aldersyde, about 40 km south of Calgary. Metal production at the Aldersyde plant is expected to start in March 1990 and increase gradually to full capacity of 12 500 t/y by the summer. The capital cost is about $100 million, and the plant will create 130 jobs. If the results of this first phase are promising and the demand for metallic magnesium remains high, the company could increase its capacity by 25 000 t by 1992. A third increase of 25 000 t/y is also envisaged for 1995, for a total annual production of 62 500 t magnesium metal. To operate at full production, the plant would require investments of $375 million and would have to employ 275 workers.

MAGCAN will use the new MPLC process, considered to be the very latest in magnesium production technology. The heart of the process is a one-stage reactor which converts the magnesite ore ($MgCO_3$) to molten anhydrous magnesium chloride, the raw material needed for electrolytic reduction to primary metallic magnesium. The process apparently uses 15% less energy than does the production of aluminum. The raw material will come from the Baymag high-grade magnesite deposit near Radium Hot Springs, British Columbia, about 300 km from High River.

In 1989, the Magnola joint venture of Noranda Minerals Inc. and Lavalin Inc. completed pilot plant test work. These tests corroborated earlier results from the pre-feasibility study, which showed that the production of metallic magnesium from asbestos tailings is technically feasible. The tests are to be followed up in 1990 with a commercial evaluation and preliminary technical studies.

The Magnola feasibility study will cost a total of $9 million, of which 50% will come from the Canada-Quebec Mineral Development Agreement. Lavalin and Noranda are committed to paying back all government grants should the Magnola project become a reality. If Magnola does go into production, investments of $500 million will be needed to build a plant with a capacity of 50 000 t/y, and some 350 jobs will be created.

In late 1989, negotiations were held between Canada and the United States regarding early elimination of customs duties on goods moving between the two countries. The negotiations follow on the January 1989 Canada-U.S. Free Trade Agreement, which allows tariffs on magnesium to be phased out over 10 years. Magnesium was not selected for early elimination of tariffs; it will, however, be reconsidered if there is a second round of negotiations.

The creation of the National Institute of Magnesium Technology (NIMT) was officially announced in September 1989. The institute is to be located in Quebec City and will be responsible for promoting the growth of the magnesium industry in Canada. Financing for the NIMT, a total of $11.4 million over a period of five years, will come from the Canada-Quebec Subsidiary Agreement on Scientific and Technological Development and the magnesium industry. The two levels of government will share equally the $5.6 million budget for construction of a building, equipment and operations. Industry participation, a total of $3.8 million, will be used for training and for contract research by the institute. Construction of a 1900 m^2 building to house the institute began in December 1989 and should be completed in 1990. The institute's research will focus on smelting and processing of molten metal, die-casting, alloys, forming methods, machining and corrosion.

Abaco Industries Inc., which used to operate a pressure die-cast magnesium and aluminum products plant in Montreal, was forced to shut down after its assets were seized. Abaco's main products were magnesium automobile parts, chain saws and sporting goods.

Meridian Technologies Inc. of Toronto became the largest die-casting company in Canada following the purchase of the division of Cygnus Industries Ltd. that declared bankruptcy in October 1989. As a result of the purchase, Meridian acquired the pressure die-casting divisions of Accurcast an Associate of Magnesium Products Industries in Strathroy, Ontario. Magnesium Products Industries is the largest Canadian manufacturer of pressure die-cast magnesium parts.

Researchers at the Canada Centre for Mineral and Energy Technology (CANMET) were awarded a four-year contract by the technical committee of the International Magnesium Association to conduct research on magnesium and corrosion at a cost of $760 000, to be borne jointly by the International Magnesium Association (IMA) and CANMET.

WORLD

The United States, which is the largest magnesium producer in the world, has three primary magnesium plants. The Dow Chemical Company, the largest U.S. producer, operates a 95 000 t/y electrolytic magnesium plant in Freeport, Texas. The magnesium chloride feedstock for the plant is derived from a seawater/dolomite process. The company reactivated idle electrolytic cells in the first quarter of 1989, adding an extra 5000 t/y of production. In 1989, the company's production capacity exceeded 1987 levels by more than 20 000 t/y. As a result of a modernization program undertaken in the 1970s and productivity improvements in the 1980s, Dow's plant is generally regarded as a very competitive operation for magnesium metal production. Dow announced the sale of its laminating facilities in Findlay, Ohio to Spectrulite Consortium.

AMAX Magnesium Corporation has been owned by Renco Group Inc. since September 1, 1989; the new company will be known as Magnesium Corporation of America (Magcorp). Production at the Magcorp plant will increase from the 1988 level of 33 000 t/y to 36 000 t/y by the end of 1990. The company, which uses an electrolytic process, employs more than 500 workers at its plant in Rowley, Utah and its head office in Salt Lake City.

The magnesium chloride feedstock for the Magcorp plant is normally derived from the natural brines of Great Salt Lake. However, high water levels on the lake in 1986 caused US$20 million in damage to the solar ponding system. In 1989, the company obtained most of its process brine from its new ponds; the rest was purchased from the old Kaiser brine operation in Wendover, near the Nevada border.

Northwest Alloys, Inc., a subsidiary of the Aluminum Company of America (Alcoa), operates a magnesium plant in Addy, Washington, which uses the Magnetherm process whereby magnesium is produced by reducing dolomite with ferrosilicon. Capacity is about 33 000 t/y, although the latest reports suggest that the 1989 rate of production was somewhat higher.

Brazil's Companhia Brasileira de Magnesio (Brasmag) secured a $20 million bank loan in order to double its current production of 6000 t/y metal magnesium. The increase in magnesium production will enable Brasmag to serve the 10 000 t/y Brazilian market. The expansion of the Bocaiuva plant will cost in the order of US$20 million. Should Brazilian officials grant Brasmag permission to build its own dam, the company will endeavour to increase its production from 12 000 t/y to 36 000 t/y.

In Colombia, the consulting firm Industrial Mineral de Colombia is looking for foreign partners for the construction of a $200 million plant with a production capacity of 30 000 t/y. The limestone and natural gas would come from deposits located near the proposed plant site on the Guajira Peninsula.

Norsk Hydro AS operates a 60 000 t/y primary magnesium plant in Porsgrunn, Norway. The plant produces magnesium by the electrolysis of magnesium chloride derived from a seawater/dolomite process and from magnesium chloride brine imported from West Germany.

Following the start-up of production at its Bécancour plant, Norsk Hydro decided to temporarily reduce production at Porsgrunn beginning in 1990. The drop in production, which should not exceed 10 000 t/y, is part of the company's modernization and anti-pollution program. Norsk Hydro must comply with a rigorous plan set by the Norwegian State Pollution Control Authority (SFT) aimed at cutting dioxin effluents in half by the end of 1989 and eliminating them altogether by January 1, 1995. The SFT also asked Norsk Hydro to submit a plan to reduce atmospheric emissions. In 1990, Norsk Hydro's total production will reach 90 000 t/y, with 50 000 t/y of that amount at Porsgrunn.

Production at the Porsgrunn plant was interrupted in August 1989 because of a fire in the control room. The fire had little affect on the company's production, since operations were halted for only a short time.

Elkem a/s revived its plans to build a magnesium metal plant in Norway. Elkem hopes to negotiate energy supply and a site for the plant with Norwegian officials. The project could be implemented in late 1990.

The modernization that began in 1987 at the Bolzano, Italy magnesium plant owned by the Societa Italiana per il Magnesio e Leghe di Magnesio was completed in 1989, bringing the capacity to 6000 t/y.

Queensland Metal Corp. of Australia is looking for a partner to build a 60 000 t/y magnesium metal plant. In 1989, the company and two associates formed the Queensland Magnesia Corp. to mine a magnesite ($MgCO_3$) deposit with estimated reserves of 800 Mt and to build a magnesia plant. Queensland Magnesia's total investment may be A$180 million.

In South Africa, Anglo American Corporation and the Rembrandt Group subsidiary, trans Hec, are conducting a feasibility study on a 10 000 t/y plant in Vredental in the western cape.

Galactic (China), a joint venture of Galactic Resources Ltd. of Vancouver and the Xinjiang Non-Ferrous Metals Corp. of China, signed a statement of intent regarding a feasibility study and planning for the construction of a magnesium metal plant in the province of Xinjiang.

Another project to produce magnesium metal is being studied in India. The Defense Metallurgical Research Laboratory in Hyderabad announced plans to build a magnesium plant with a production capacity of 1000 t/y in five years. The process would consist of recycling the magnesium chloride derived from the production of titanium using the Kroll process.

In Japan, UBE Industries Ltd. announced that it was planning to increase its production capacity from 6000 t/y to 9000 t/y. The increase will be made possible primarily by the reconditioning of unused furnaces. Japan Metals & Chemicals Co. Ltd. (JMC), which in 1988 completed construction of a plant with an initial production capacity of 3000 t/y, increased production to 5000 t/y in 1989. The JMC plant, located in Takaoka in western Honshu, uses the Magnetherm process. As announced, Furukawa Magnesium Company closed its 3000 t/y plant in March 1989.

The Japanese market, which consumes approximately 25 000 t/y, has a strong growth potential.

PRICES

By December 1989, magnesium stocks had increased by 6000 t over the December 1988 level of 28 000 t.

In this context, prices remained stable in 1989 at US$1.43/lb. for die-casting alloy AZ91D, and US$1.63/lb. for primary ingots and other alloys. The start-up of production at Norsk Hydro's plant in Bécancour and at the MAGCAN plant in Alberta, which will increase world production by more than 50 000 t/y, forced prices downward at the end of the year.

The price of aluminum 380, which has some applications similar to magnesium in the die-casting alloys sector, dropped by more than 28% from US$1.00/lb. to US$0.78/lb.

CONSUMPTION AND MARKETS

The main application of magnesium is as an alloying agent with aluminum, accounting for close to 53% of non-socialist consumption in 1989. Despite the 10% increase that occurred between 1987 and 1988, consumption for this application decreased by 2.9% between 1988 and 1989, reaching 130 400 t. It is predicted that magnesium consumption for this application will remain stable over the next few years as the result of an increase in the recycling of cans and a reduction of their thickness.

The second largest use of magnesium is as a deoxidizing and desulphurizing agent in the ferrous industry. The demand for magnesium in 1989 was 32 300 t, 12.9% higher than in 1988. This sector, which has grown an average of 15% per year over the past six years, should continue its rapid growth because of a considerable increase in demand in Europe.

The third largest use of magnesium is in structural applications, of which pressure die-cast products constitute the most important use. Consumption increased from 21 000 t in 1982 to 28 600 t in 1989, and should exceed 50 000 t within five years. During the next decade, this sector should show more growth than any other application of magnesium.

Magnesium die-casting has a number of advantages over aluminum, such as its lower heat of solidification, which increases die-casting production capacity by approximately 25% and results in major process energy savings. In addition, magnesium dies are reported to last as much as two times longer than aluminum dies. Some aluminum parts which require several castings can be produced in magnesium with a single casting. Furthermore, some die-casters note that even at a magnesium-aluminum price ratio of 1.7:1, some magnesium metal parts can be fabricated at the same cost as those made of aluminum.

Greater awareness of energy conservation and air pollution, owing primarily to recent studies of the greenhouse effect, has led the U.S. government to take steps aimed at reducing carbon dioxide emissions. In 1989, the U.S. government announced that stricter CAFE (Corporate Average Fuel Economy) requirements would come into effect in 1990. The average consumption of new vehicles produced in the United States will increase from 26 miles per gallon in 1989 to 27.5 miles per gallon in 1990. The CAFE requirements were enacted by Congress as part of the 1975 Energy Policy and Conservation Act. There are also plans to raise new vehicle consumption again in the near future in order to reduce pollution in major urban centres in the United States.

According to some reports, the consumption levels for new vehicles will be reached through improved traction (50%), reduced weight (35%) and modifications related to friction and aerodynamics (15%). If the only means of reaching the new consumption levels were to reduce vehicle weight, 250 pounds would have to be eliminated to obtain one extra mile per gallon.

A number of projects have been carried out in recent years to increase the short-and medium-term use of die-cast magnesium parts. The Aerotech project, a joint venture of Fueling Engineering and the Oldsmobile Division of General Motors Corporation, was set up to develop a super-heavy-duty Quad 4 engine with a magnesium structure. It is estimated that the use of magnesium instead of aluminum could save about 25 kg, which would reduce the total weight by almost one third.

Honda Motor Co. Ltd. offered magnesium rims instead of aluminum ones on its 1989 Preludes. The new 5.9 kg rim made the car more than 20% lighter. In terms of energy savings and efficiency, making a wheel rim 1 kg lighter is thought to be the same as making other components 1.75 kg lighter because the wheel undergoes rotary acceleration. Other automobile manufacturers recently announced plans to make greater use of magnesium. Both the Toyota Motor Corporation and the Ford Motor Company, for example, plan to use magnesium for the valve covers in some of their models. The decision by General Motors Corporation to use magnesium for the steering columns on the Regal and Cavalier will increase magnesium consumption by 0.75 kg per vehicle.

Finally, as part of its program to improve vehicle safety, the Ford Motor Company has equipped some of its 1990 models with a pneumatic protective device. Approximately 2 kg of magnesium will be used to anchor the new device.

According to the manufacturer of the device, Diemakers Inc., the use of magnesium instead of aluminum, zinc or steel will ensure weight savings in the order of 50% and reduce the number of parts by half. The use of magnesium also leads to lower costs and greater reliability. It is estimated that the consumption of magnesium for the device could reach 3000 t/y within three years. Other carmakers will undoubtedly follow suit in the next few years, thereby creating new opportunities for this application. Teams of specialists from the major magnesium producers are making consultants available to automobile manufacturers to suggest appropriate uses for the metal.

Aside from automotive applications, die-cast magnesium products are widely used in the manufacture of portable tools and sporting goods. The use of magnesium in electronic equipment, particularly computer housings and components, has grown substantially, and this trend is expected to continue. Magnesium is preferred for these applications not only because of its good strength-to-weight ratio, but also because it dissipates heat well and confines electro-magnetic fields and radio frequency interference. Chicago White Metal Casting Inc. specializes in this type of casting and recently acquired equipment with a higher capacity and greater precision.

Magnesium is also used to produce nodular iron (16 900 t or 6.9%), primarily ductile iron pipes and die-cast parts for use in automobiles and farm equipment, and as a reducing agent (9400 t or 3.8%) in the production of titanium, beryllium, zirconium, hafnium and uranium. Chemical applications (5500 t or 2.2%) include the manufacture of pharmaceutical products, perfumes and pyrotechnics. Electrochemical applications account for 3.3% of magnesium consumption for use in the manufacture of batteries and anodes for cathodic protection of gas pipelines and water heaters. Wrought products (2.5%) mainly include extruded products except anodes, sheets and plates; gravity casting (1%) includes the production of complex or large parts by sand-casting or with other materials. Other applications together account for 2.8% of magnesium consumption.

OUTLOOK

Within five years, magnesium consumption should rise to more than 325 000 t/y, primarily because of the substantial increase expected in the die-casting of automobile parts and the desulphurization of steel.

The magnesium industry, which has undergone tremendous change in recent years primarily as a result of plant rationalizations and the construction of new plants, will remain in a period of transition. Total production capacity should increase by approximately 40 000 t/y in 1990.

Despite the commissioning of two large plants in Canada in 1990, the balance between magnesium supply and demand is not expected to be upset in the short term because world inventories have been abnormally low for the past two years and a number of companies are implementing partial shut-downs or are rationalizing their production.

However, the prospect of a recession could have considerable impact on some uses of magnesium, particularly in aluminum alloying and steel desulphurization. A slowdown in economic activity would have less impact in the die-casting sector, because even if the number of vehicles produced decreases, the use of magnesium in this sector has such growth potential that there would likely be a substantial increase in consumption. A slowdown would, however, affect magnesium prices. In addition, rationalizations could force the producers with the highest costs to cut their production or abandon the market.

If growth in consumption is to be sustained, magnesium will have to perform well, especially against aluminum in the automobile parts sector. A long-term magnesium-aluminum price ratio of 1.5:1 could lead to a variety of new applications.

Canada has a number of competitive edges, including cheap and abundant energy, easy access to raw materials and proximity to the American market, which could make it the most powerful force in the industry.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

		Canada			United States	EEC	Japan[1]
Item No.	Description	MFN	GPT	USA	Canada	MFN	MFN
81.04	Magnesium and articles thereof, including waste and scrap						
	- Unwrought magnesium:						
8104.11.00.00	-- Containing at least 99.8% by weight of magnesium	4%	2.5%	3.2%	7.2%	5.3%	6.5%
8104.19.00.00	-- Other	4%	Free	3.2%	5.8%	5.3%	6.5%
8104.20.00.00	-- Waste and scrap	Free	Free	Free	Free	Free	3.2%
8104.30	- Raspings, turnings and granules, graded according to size; powders						
8104.30.10.00	--- Raspings, turnings and granules; powders, alloyed	10.2%	6.5%	8.1%	5.8%	5.3%	7.2%
8104.30.20.00	--- Powders, not alloyed	4%	2.5%	3.2%	5.8%	5.3%	7.2%
8104.90	- Other						
8104.90.10	--- Bars, rods, plates, sheets, strip, foil, tubes and pipes, alloyed	4%	Free	3.2%	3.1%	5.3%	7.2%
8104.90.10.10	----- Bars and rods	4%	Free	3.2%	3.1%	5.3%	7.2%
8104.90.10.20	----- Plates, sheets, strip, foil, tubes and pipes	4%	Free	3.2%	3.1%	5.3%	7.2%
8104.90.90	--- Other	10.2%	6.5%	8.1%	3.1%	5.3%	7.2%
8104.90.90.10	----- Structural shapes	10.2%	6.5%	8.1%	3.1%	5.3%	7.2%
8104.90.90.90	----- Other	10.2%	6.5%	8.1%	3.1%	5.3%	7.2%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Customs Tariff Schedules of Japan, 1989.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, MAGNESIUM EXPORTS AND IMPORTS BY COMMODITIES AND COUNTRIES, 1988 AND 1989

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
8104.11	Magnesium unwrought containing by weight at least 99.8% of magnesium				
	Australia	256	1 470	247	1 475
	United Kingdom	514	2 877	167	1 094
	Switzerland	574	3 271	69	511
	United States	781	3 493	133	500
	Other countries	1 338	6 233	284	1 525
	Total	3 463	17 344	900	5 105
8104.19	Magnesium unwrought. n.e.s.				
	United States	184	1 294	102	513
	Australia	49	224	9	61
	Other countries	64	323	10	52
	Total	297	1 841	121	626
8104.20	Magnesium waste and scrap				
	United States	1 888	4 672	358	1 243
	South Korea	–	–	63	218
	Italy	–	–	6	11
	United Kingdom	19	57	–	–
	Total	1 907	4 730	427	1 473
8104.30	Magnesium raspings, turnings or granules graded according to size and powders				
	United States	. .	1 555	302	1 728
	Ireland	. .	120	60	427
	South Korea	. .	944	30	166
	Other countries	. .	118	32	213
	Total	. .	2 737	424	2 534
8104.90	Magnesium and articles thereof, n.e.s				
	United States	226	4 207	10	134
	Other countries	27	765	3	23
	Total	253	4 972	13	157
	Total Exports	5 920	31 624	1 885	9 895
Imports					
8104.11	Magnesium unwrought containing by weight at least 99.8% of magnesium				
	United States	4 467	15 687	4 110	14 455
	Norway	40	151	93	355
	France	54	201	72	297
	Other countries	. . .	1	4	19
	Total	4 561	16 040	4 279	15 126
8104.19	Magnesium unwrought n.e.s.				
	United States	2 541	8 732	2 906	9 685
	Norway	1 056	3 490	1 238	4 250
	United Kingdom	183	1 455	204	1 434
	France	197	738	160	662
	Canada	19	51	–	–
	Total	3 996	14 468	4 508	16 033

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
8104.20	Magnesium waste and scrap				
	United States	67	164	70	181
	Total	67	164	70	181
8104.30.10	Magnesium raspings, turnings or granules, graded according to size and powders, alloyed				
	United States	34	128	2	11
	Total	34	128	2	11
8104.30.20	Magnesium powders, not alloyed				
	United States	249	1 033	15	75
	Other countries	16	67	–	–
	Total	265	1 100	15	75
8104.90.10.10	Magnesium bars and rods				
	United States	2 096	6 257	915	2 997
	France	123	526	18	74
	United Kingdom	47	141	–	–
	Total	2 266	6 925	933	3 071
8104.90.10.20	Magnesium plates, sheets, strip, foil, tubes and pipes				
	United States	126	1 430	73	1 100
	Total	126	1 430	73	1 100
8104.90.90.10	Magnesium structural shapes				
	United States	30	586	18	142
	Total	30	586	18	142
8104.90.90.90	Magnesium articles n.e.s.				
	United States	130	819	256	1 634
	Canada	–	–	21	579
	Other countries	–	–	2	13
	Total	130	819	279	2 226
	Total Imports	11 475	41 660	10 177	37 965

Source: Statistics Canada.
p Preliminary; – Nil; . . Not available; . . . Amount too small to be expressed; n.e.s. Not elsewhere specified.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CONSUMPTION[1] OF MAGNESIUM, 1982-88

	1982	1983	1984	1985	1986[r4]	1987[r]	1988[p4]
				(tonnes)			
Castings and wrought products[2]	574	490	550	453	2 628	3 837	5 067
Aluminum alloys and other uses[3]	4 431	5 078	6 296	6 129	6 098	5 632	8 157
Total	5 005	5 568	6 846	6 582	8 726	9 469	13 224

[1] Available data, as reported by consumers. [2] Die, permanent mould and sand castings, structural shapes, tubings, forgings, sheet and plate. [3] Cathodic protection, reducing agents, deoxidizers and other alloys. [4] Increase in number of companies being surveyed.
[p] Preliminary; [r] Revised.

TABLE 3. WORLD PRIMARY MAGNESIUM PRODUCTION, 1982-88

	1982	1983	1984	1985	1986	1987[p]	1988[e]
				(000 tonnes)			
Canada	7.9	6.0	8.0	7.0	8.2	7.0	7.6
United States	89.9	104.7	144.4	135.9	117.9	124.4	142.0
U.S.S.R.	77.0	80.0	85.0	85.0	85.3	90.0	91.0
Norway	35.9	29.9	48.3	54.7	56.5	50.0	51.7
France	9.6	10.9	12.8	13.8	13.8	14.0	14.0
Italy	9.9	9.8	8.2	7.9	9.1	11.0	4.5
People's Republic of China	7.5	8.5	8.5	9.0	9.1	7.0	7.0
Japan	5.6	6.0	7.1	8.4	9.1	8.2	10.0
Yugoslavia	4.2	4.7	5.1	4.9	4.5	4.5	4.2
Poland	0.5	-	-	-	-	-	-
Brazil	0.3	0.5	1.2	2.6	4.5	5.8	5.9
India	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Total	248.4	261.1	328.7	329.1	318.1	322.0	338.0

Source: American Bureau of Metal Statistics.
[p] Preliminary; [e] Estimated; - Nil.

TABLE 4. PRIMARY MAGNESIUM PRODUCTION BY WORLD ZONE,[1] 1980-89

Period	Area 1 United States and Canada	Area 2 Latin America	Area 3 Western Europe	Area 5 Asia and Oceania	Total
			(000 tonnes)		
1980	163.0	–	64.4	9.2	236.6
1981	138.4	–	64.4	5.7	208.5
1982	97.8	–	52.8	5.8	156.4
1983	109.0	–	51.0	6.0	166.0
1984	152.8	1.0	71.6	6.7	232.1
1985	142.9	2.0	80.8	8.2	233.9
1986	130.7	3.7	81.4	8.1	223.9
1987	133.2	5.2	84.0	7.9	230.3
1988	149.6	5.8	76.2	9.6	241.2
1989	158.4	6.2	76.5	11.7	252.8

Source: International Magnesium Association.

[1] There is no production in Area 4, Africa and the Middle East.

– Nil.

TABLE 5. PRIMARY MAGNESIUM SHIPMENTS BY WORLD ZONE, 1980-89

Period	Area 1 United States and Canada	Area 2 Latin America	Area 3 Western Europe	Area 4 Africa and Middle East	Area 5 Asia and Oceania	Area 6 Other	Total
				(000 tonnes)			
1980	111.0	17.0	66.0	2.0	23.0	–	219.0
1981	104.0	12.0	61.0	2.0	24.0	–	203.0
1982	85.8	8.3	60.6	1.3	17.7	–	173.7
1983	98.6	9.6	60.4	2.4	33.4	–	204.4
1984	110.1	8.0	66.8	1.6	29.5	–	216.0
1985	102.4	9.4	72.2	2.4	38.4	–	224.8
1986	103.3	11.3	73.6	3.2	35.0	–	226.4
1987	113.7	8.3	66.9	5.2	28.7	13.2	236.0
1988	125.0	11.7	70.6	3.8	33.8	6.2	251.2
1989	128.1	9.1	69.2	2.7	33.0	4.1	246.2

Source: International Magnesium Association.

– Nil.

TABLE 6. PRIMARY MAGNESIUM SHIPMENTS BY WORLD ZONE AND CATEGORY, 1989

Use	Area 1 United States and Canada	Area 2 Latin America	Area 3 Western Europe	Area 4 Africa and Middle East	Area 5 Asia and Oceania	Area 6 Other	Total
				(000 tonnes)			
Aluminum alloying	61.8	2.5	37.7	2.3	26.1	-	130.4
Nodular iron	6.3	0.6	6.6	0.3	3.1	-	16.9
Desulphurization	22.4	-	9.9	-	-	-	32.3
Metal reduction	7.8	0.3	0.9	-	0.4	-	9.4
Electrochemical applications	6.6	0.5	0.6	-	0.4	-	8.1
Chemical applications	1.6	-	2.9	-	1.0	-	5.5
Die-casting	13.7	5.3	7.7	-	1.9	-	28.6
Gravity casting	0.7	-	1.7	-	0.1	-	2.5
Wrought products	25.4	-	0.7	-	0.1	-	6.2
Other	0.9	0.2	0.8	-	0.9	4.1	6.9
Total	127.2	9.4	69.5	2.6	34.0	4.1	246.8

Source: International Magnesium Association.
- Nil.

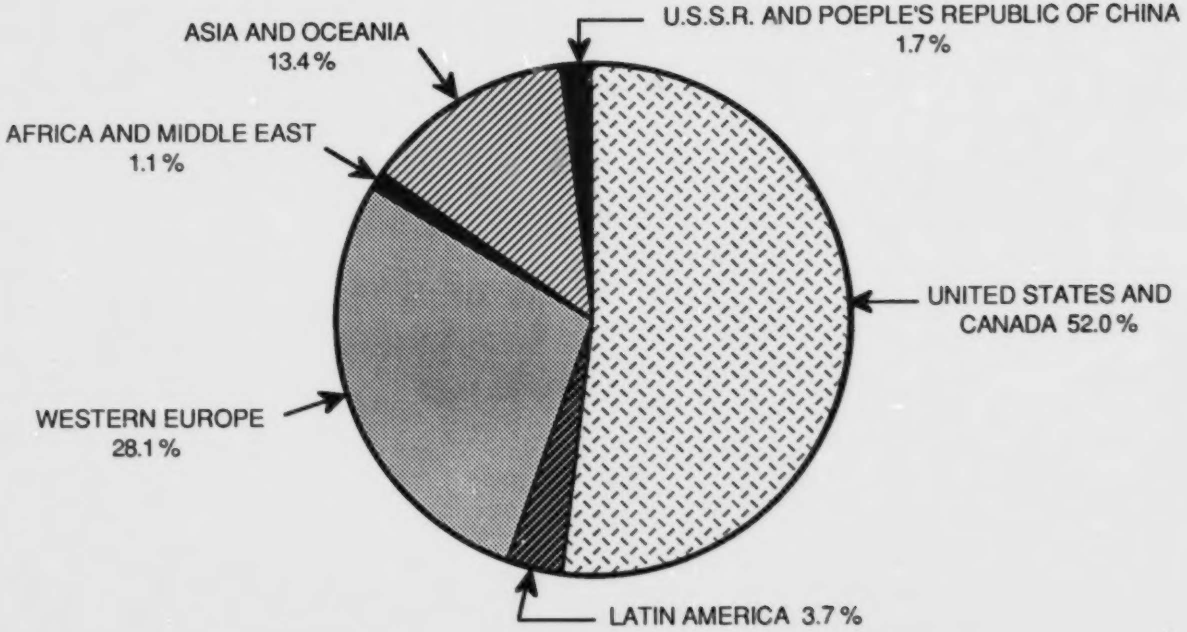
TABLE 7. MAGNESIUM PRODUCERS - NEW DEVELOPMENTS

Producer	Plant Location	Production Capacity (t/y)	Remarks
CANADA			
Norsk Hydro Canada Inc	Becancour, Quebec	40 000	Production began in the last quarter of 1989; production capacity could reach 60 000 t/y within three years
Magnesium Company of Canada Ltd (MAGCAN)	Aldersyde, Alberta	12 500	Production will begin in the first quarter of 1990; production capacity could increase to 37 500 t/y by 1993 and to 62 500 t/y by 1995
Timminco Limited	Haley Station, Ontario	6 000	
Noranda Minerals Inc - Lavalin Inc (Magnola)	East Broughton, Quebec	50 000	The feasibility study will be completed by the end of 1990
UNITED STATES			
The Dow Chemical Company	Freeport, Texas	95 000	
Magnesium Corporation of America (Magcorp)	Rowley, Utah	36 000	AMAX Magnesium Corporation has been owned by the Renco Group Inc since September 1, 1989
Northwest Alloys, Inc	Addy, Washington	33 000	Northwest Alloys, Inc is a subsidiary of the Aluminum Company of America (Alcoa)
COLOMBIA			
Industrial Mineral de Colombia	Guajira Peninsula	20 000	This project is under study and partners are being sought
BRAZIL			
Companhia Brasileira de Magnesio (Brasmag)	Bocaiuva	6 000	A project is currently under way to increase production capacity from 6000 to 10 000 t/y at a cost of US$20 million

TABLE 7. (cont'd)

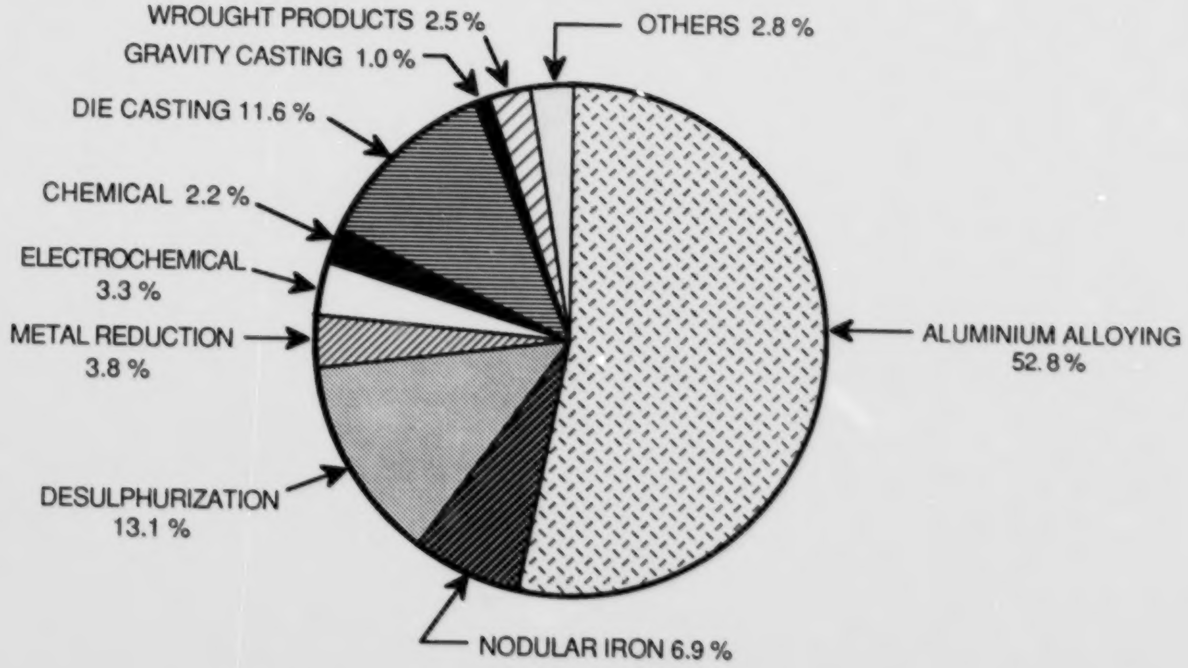
Producer	Plant Location	Production Capacity (t/y)	Remarks
WESTERN EUROPE			
Norsk Hydro AS	Porsgrunn, Norway	62 000	The plant's production capacity will be temporarily reduced by 10 000 t/y beginning in 1990 in order to modernize anti-pollution equipment.
Elkem a/s	Norway	20 000	Negotiations with government authorities concerning energy supply and plant location should be under way.
Societa Italiana per il Magnesio e Leghe di Magnesio	Bolzano, Italy	6 000	Recent rationalization lowered production capacity from 10 000 to 6000 t/y.
Pechiney Electrométallurgie	Marignac, France	15 000	
Magnahorn	Yugoslavia	9 000	
ASIA AND OCEANIA			
UBE Industries Ltd	Japan	9 000	UBE recently announced an increase in production from 6000 to 9000 t/y.
Japan Metals & Chemicals Co. Ltd	Takaoka, Japan	5 000	Production capacity went from 3000 to 5000 t/y in 1989.
Furukawa Magnesium Company	Japan	3 000	This plant closed in March 1989.
Queensland Metal Corp	Australia	60 000	Queensland Metal is looking for a partner to build a plant.
Defense Metallurgical Research Laboratory	Hyderabad, India	1 000	This plant is to be constructed within five years.
AFRICA			
Anglo American Corporation and the Rembrandt Group subsidiary, Trans Hex	Vredendal, South Africa	10 000	A feasibility study is presently being carried out for a plant using the Nintex/Samancor process.

PERCENTAGE OF MAGNESIUM METAL
Shipments by World Zone, 1989



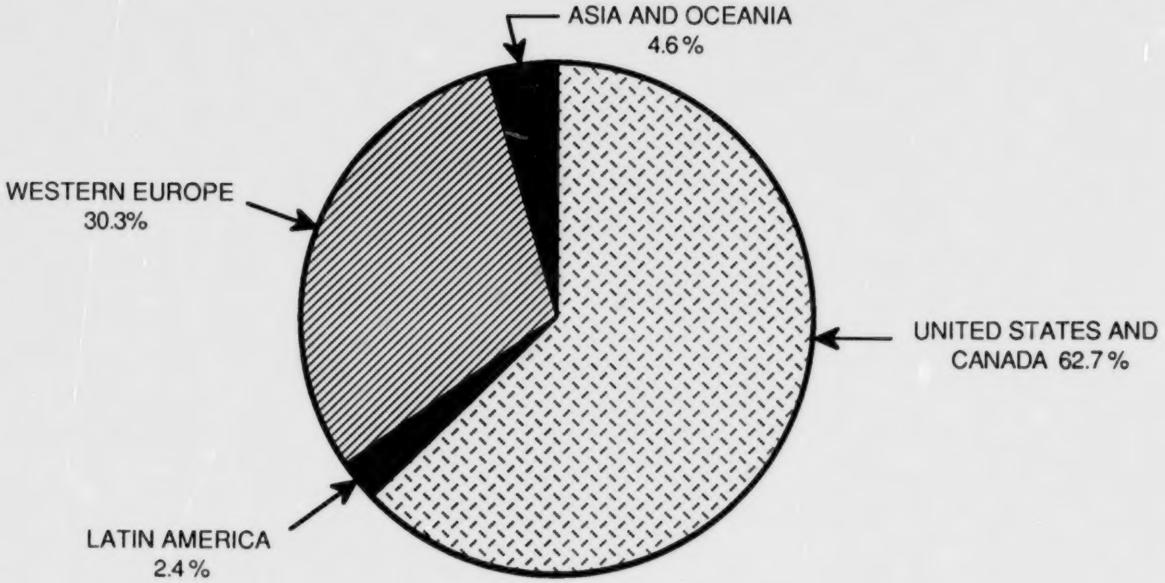
SOURCE: INTERNATIONAL MAGNESIUM ASSOCIATION

PERCENTAGE OF MAGNESIUM SHIPMENTS
By Use in 1989



SOURCE: INTERNATIONAL MAGNESIUM ASSOCIATION

PERCENTAGE OF MAGNESIUM METAL
Production by World Zone, 1989



SOURCE: INTERNATIONAL MAGNESIUM ASSOCIATION

Manganese

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SUMMARY

Manganese occurs naturally in minerals such as pyrolusite, manganite, psilomelane and rhodochrosite. High-grade manganese (30%-50% Mn) ores occur in the U.S.S.R., the Republic of South Africa, Brazil, Gabon and Australia. These are mined and upgraded to produce concentrate. The ores are also upgraded to produce manganese ferroalloys (high-, medium- and low-carbon ferromanganese and silicomanganese), manganese metal, synthetic manganese dioxide and other manganese chemicals.

Approximately 90% of the manganese consumed is used in metallurgical applications. Manganese ferroalloys and manganese metal are used in the production of iron and steel; manganese metal is also used in the production of nonferrous products. The non-metallurgical applications include the use of ore to produce manganese chemicals for use in fertilizers, bricks, paint and for water purification.

Canada consumed an estimated 105 000 t of manganese ferroalloys in 1989, about 7% less than in the previous year. Western world consumption of manganese ferroalloys in 1989 was estimated at 2.57 Mt of contained manganese, an increase of about 1% over consumption in 1988.

Production of manganese ferroalloys in the western world was estimated at 4.04 Mt in 1989, representing an increase of 6% compared to production in 1988. Western world production and consumption of manganese metal remained high in 1989 and 1988, and was estimated at 67 000 t in 1989.

World mine production of manganese ore in 1989 was estimated at 27.3 Mt, an increase of 5.5% over the previous year. Production of manganese ore in the U.S.S.R. in 1989 was estimated at 11.0 Mt, about equal to the other major world producers which were, in order of rank, the Republic of South Africa, Brazil, Gabon and Australia.

CANADIAN DEVELOPMENTS

In 1989, Canada remained dependent on imports of manganese ore for the production of all ferroalloys and non-metallurgical products. No domestic mining has been carried out to date, mainly due to the low ore grades of known deposits. Canada was also import-dependent on manganese metal for the domestic production of its iron, steel, nonferrous and non-metallurgical products, the majority of which are manufactured in Ontario and Quebec.

Canada's only producer of manganese ferroalloys in 1989 was Elkem Métal Canada Inc. The company operated at near capacity in 1988 and 1989. Elkem Métal's 130 000 t/y smelter at Beauharnois was fully utilized in 1989 for the production of high-carbon ferromanganese and silicomanganese.

Timminco Limited, whose ferroalloys facility is also located at Beauharnois, was closed down in May 1987 for three months. Prior to the shut-down, the company produced both manganese and silicon ferroalloys. Since re-opening the plant in August 1987, the company has produced only silicon ferroalloys, and the company's manganese ferroalloy facility has remained mothballed.

Consumption of manganese ferroalloys in Canada remained fairly stable throughout the period 1987 to 1989. On average, during this period, it was about 27% higher than in 1986 due to an increase in the demand for these alloys in the domestic production of iron and steel. Canada consumed 105 000 t of manganese ferroalloys in 1989, 6% less than the previous year. The reduction in consumption is attributed to a softening of steel markets in the latter half of the year.

The trend to increased consumption of silicomanganese in the production of steel, which started in the mid-1970s, continued into the 1980s. The consumption ratio of ferromanganese to silicomanganese, which stood at 4:1 in 1975, was reduced to 3:1 by 1985, and the reduction has been maintained by the Canadian steel industry ever since.

Canada's exports and imports of ferromanganese and its imports of silicomanganese in 1989 remained about the same as the previous year. Imports of manganese ore in 1989 increased by 25%. Canada remained totally dependent on imports of manganese metal in 1989 for the production of its nonferrous metals and its iron and steel. The battery and chemical industries are also dependent on imports of manganese dioxide for the production of their products.

HEALTH, SAFETY AND ENVIRONMENT

Although the major sources of manganese effluent originate in the manufacture of alloys, steel and iron products, Canada's manganese ferroalloy industry has considerably reduced manganese emissions in the last decade. Other sources of manganese emissions include the combustion of fuel additives, the mining of manganese ores, the production of fertilizers and the use of manganese oxides for dry-cell battery production.

WORLD DEVELOPMENTS

The world supply/demand balance for manganese ferroalloys remained constant throughout the period 1985 to 1989 with consumption exceeding production on average by 3.4%.

Western world consumption of manganese ferroalloys was estimated at 2.57 Mt of contained manganese in 1989, about equal to consumption in 1988. This level of consumption was about 6% higher than in 1987. The increase was associated with the high demand for these alloys in the production of iron and steel.

On a regional basis, Western Europe accounted for an estimated 38% of total western world consumption and Asia 35%. Japan accounted for an estimated 54% of the Asian consumption.

North American consumption of manganese ferroalloys in 1989 was estimated at 420 000 t of contained manganese, which was 5000 t less than consumed by Japan.

Consumption of manganese metal remained constant in the last two years due to high demand by the industries producing aluminum, bronze and magnesium products. These major consumers have become concerned about their dependence on South Africa, the largest producer and exporter of manganese metal. Demand for manganese dioxide has remained high for the past three years due to the sustained consumption in production in the battery, chemical and fertilizer industries.

Western world consumption of manganese metal in 1989 was estimated at 68 500 t, and it exceeded production by 2.2%. The supply deficit was met by withdrawal from stocks.

Western world production of manganese ferroalloys peaked in 1989 at an estimated 4.04 Mt, which was the highest for the period 1985 to 1989, and 6% higher than in 1988.

Western Europe, mainly France and West Germany, accounted for 31% of the total western world production of high-carbon ferromanganese. The other major world producers of high-carbon ferromanganese were: Japan 14%, the Republic of South Africa 15%, Brazil and India 7%, and Canada 4%. Norway accounts for about the same production as Canada. The largest producers of medium- and low-carbon ferromanganese were, in order of rank, Norway, Japan, West Germany, Mexico and France.

The largest producers of silicomanganese, in order of rank, were the Republic of South Africa, Norway, Brazil and Japan. These four countries accounted for an estimated 62% of the western world's production.

The world's manganese metal production capacity, estimated at 68 000 t/y, has been fully utilized for the past three years. Additional capacity has been added in the United States, estimated at 2500 t, and a further 3300 t facility in Australia is in the pre-production phase. The U.S.S.R., at 11 Mt, and South Africa, at 3.7 Mt, accounted for about 55% of world mine production of manganese ore in 1989.

The other major world producers of manganese ore in 1989 include: Brazil 2.95 Mt, Gabon 2.65 Mt and the People's Republic of China 1.76 Mt. The People's Republic of China and India's combined production of manganese ores and concentrate in 1989 totalled 3.25 Mt. This indicates a continuing trend to produce silicon ferroalloys in lesser developing countries.

South Africa continues to dominate the western world manganese industry. In addition to producing 23% of the ore in 1989, it is the world's second largest producer of manganese ferroalloys and the largest producer of manganese metal, with 50% of the production.

Current world electrolytic manganese dioxide capacity is estimated at 152 000 t/y, of which 24% is located in the United States, 13% in South Africa, and 34% in Japan. This capacity was fully utilized in 1989.

For importers of ferroalloys the U.S.S.R. has become somewhat of a focal point with regard to manganese, as it is for chromium. Manganese supply by the U.S.S.R. to world markets is currently interesting from three aspects.

There are claims that the U.S.S.R. high-grade manganese ores are depleting and could run out by the year 2000. This could drastically affect world supply as the U.S.S.R. currently accounts for 40% of world production.

Secondly, the U.S.S.R. has attempted to acquire additional hard currency by exporting ores, even though domestic demand will increase under the current short- and medium-term plans for increased production of iron and steel for its manufacturing industries.

The third aspect, as given in recent reports in the International Press, is that the U.S.S.R. is seeking technological assistance in developing and expanding its metallurgical industries. Reports in the Canadian Press have also indicated that Stelco Inc. may sign an agreement with the U.S.S.R. on technology development.

Elkem a/s and BHP-Utah International Inc. signed a letter of intent in November 1989 to facilitate a joint venture between Elkem Métal and BHP's ferroalloy subsidiary, Thailand Exploration and Mining Co. Ltd. (TEMCO), located at Bell Bay in Tasmania.

BHP's Bell Bay smelters have the potential capacity to produce about 180 000 t/y of ferromanganese and silicomanganese. Current press reports have indicated that the Bell Bay smelters produced ferrosilicon and silicomanganese in 1988. The joint venture could lead to further diversification in the production by both companies, and is aimed at the efficient utilization of the companies' existing plants in order to take advantage of future marketing opportunities, particularly in Japan.

An agreement between the Gabonese government and COMILOG to complete the trans-Gabon railroad and the construction of a port at Owendo was finalized in 1988 and both are currently in operation.

PRICES

Manganese ore prices peaked in December at US$330/t. In 1989, prices averaged US$264/t, compared to an average price of $155/t in 1988. Consumption of manganese ore was about equal to production in 1989 and this led to tight markets which resulted in substantial price increases.

A similar trend was experienced with respect to price increases for manganese ferroalloys. High-carbon ferromanganese prices, which averaged US$342 in 1987, increased to US$490 in 1988 and further increased to US$609 in 1989.

Medium-carbon ferromanganese prices averaged US$1135/t in 1988 and US$1285/t in 1989. Prices for silicomanganese averaged US$595/t in 1988 and US$710/t in 1989. Manganese metal prices averaged $2005/t in 1988 and $2060/t in 1989.

OUTLOOK

Technology is not expected to greatly affect the unit consumption of manganese in current end uses such as iron and steel, nonferrous metals, batteries, chemicals and refractories in the short term. Hence, prices for manganese, which rose at the end of 1989, should stabilize by the end of 1990.

Prices for ores which steadily increased from 1987, and averaged about US$264/t in 1989, are expected to decline in the first half of 1990. However, prices could later increase due to a forecasted increase in demand for iron and steel projected for 1992 and 1993.

Gabon could play a major role in the future supply of manganese ore. Previously, Gabon was restricted in the shipment of its ore. However, the completion of its railroad and new harbour could lead to Gabon becoming the second largest producer of manganese ore by 1995. The claims that high-grade ores are depleting in the U.S.S.R. could also fuel the escalation of Gabon's production output even earlier than projected.

Consumption of manganese ore used to produce manganese ferroalloys is expected to decline about 5% in 1990 due to reduced demand for ferromanganese by the iron and steel industry.

Manganese metal consumption is expected to increase in the short term due to higher demand for nonferrous products, such as those used in the automotive, aerospace and large appliance industries. Manganese dioxide consumption is forecast to remain unchanged in the short term due to stable demand in the battery, chemical and fertilizer industries.

Note: *Information contained in this review was current as of mid-January 1990.*

PRICES

Manganese prices published by **Metals Week**	1987			1988			1989		
	January	July	December	January	July	December	January	July	December
					(US$)				
Manganese ore, (per tonne c.i.f.)									
U.S. ports, Mn content Min. 48% Mn (low impurities)	125.95 - 137.80	125.95 - 137.80	125.95 - 137.80	132.84 - 137.80	147.60 - 162.36	147.60 - 162.36	147.60 - 162.36	147.60 - 162.36	300.00 - 330.00
Ferromanganese, f.o.b. shipping point, carload lots, lump, bulk Standard 78% Mn, (per tonne)	300.12 - 314.88	334.56 - 344.40	373.92 - 383.76	373.92 - 383.76	477.24 - 496.82	590.40 - 606.16	590.40 - 615.00	610.08 - 624.84	600.24 - 629.76
					(US¢)				
Medium-carbon, 80-85% Mn, (per kg Mn)	70.56 - 74.97	76.07 - 81.59	81.59 - 83.79	99.26 - 108.05	99.26 - 108.05	122.53 - 125.69	121.28 - 125.69	132.30 - 136.71	127.89 - 134.51
Silicomanganese, (per kg of alloy), f.o.b. shipping point, 65-68% Mn, 16-18.5% Si, 0.2% P, 2% C	37.49 - 39.69	40.79 - 43.00	49.61 - 52.92	48.51 - 52.92	56.23 - 57.88	68.36 - 70.56	79.38 - 81.59	90.40 - 92.61	52.92 - 59.54
Manganese metal, (per kg of product), f.o.b. shipping point Regular, minimum 99.5% Mn	176.40	176.40	189.63	189.63	189.63	200.65 - 211.68	200.65 - 211.68	200.65 - 211.68	200.65 - 211.68

Sources: Metal Week, Energy Mines and Resources Canada.
f.o.b. Free on board; c.i.f. Cost, insurance and freight.

TARIFFS

Item No.	Description	Canada MFN	 GPT	 USA	United States Canada
2602.00.00	Manganese ores and concentrates, including manganiferous iron ores and concentrates with a manganese content of 20% or more, calculated on the dry weight	Free	Free	Free	Free
2530.90.50	Natural manganese oxides	Free	Free	Free	Free
8111.00.10	Unwrought manganese, not alloyed; powders, not alloyed	Free	Free	Free	
8111.00.10.10	-- Unwrought manganese				12.6%
8111.00.10.20	-- Powders				4.9%
8111.00.20	Unwrought manganese, alloyed; waste and scrap; powders, alloyed; articles of manganese	10.2%	6.5%	8.1%	
8111.00.20.10	-- Unwrought manganese				12.6%
8111.00.20.20	-- Waste and scrap				Free
8111.00.20.30	-- Powders				4.9%
8111.00.20.40	-- Articles of manganese				4.9%
72.02	Ferromanganese				
7202.11	-- Containing by weight more than 2% of carbon				
7202.11.10	--- Containing by weight not more than 1% of silicon	0.88¢/kg or fraction thereof on the manganese content	Free	Free	
7202.11.10.10	----- Containing by weight more than 2% but not more than 3% of carbon				Free
7202.11.10.20	----- Containing by weight more than 3% of carbon				Free
7202.11.20	--- Containing by weight more than 1% of silicon	1.54¢/kg or fraction thereof on the manganese content	Free	Free	Free

7202.19	-- Other ferromanganese				
7202.19.10	--- Containing by weight not more than 1% of silicon	0.88¢/kg on the manganese content	Free	Free	Free
7202.19.20	--- Containing by weight more than 1% of silicon	1.54¢/kg on the manganese content	Free	Free	Free
7202.30.00	Ferro-silicomanganese	1.54¢/kg or fraction thereof on the manganese content	Free	Free	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, MANGANESE TRADE, 1988 AND 1989 AND CONSUMPTION, 1986–88

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports					
2530.90.50	Natural manganese oxides				
	United States	168	73	–	–
	Total	168	73	–	–
2602.00.00	Manganese ores and concentrates, including manganiferous iron ores and concentrates with a manganese content of 20% or more, calculated on the dry weight				
	South Africa	31 737	6 608	21 289	3 979
	Australia	–	–	9 388	2 997
	France	21 761	4 289	11 529	2 202
	United States	2 909	1 597	3 298	1 482
	Mexico	29 504	1 590	4 716	838
	Greece	547	192	327	74
	Brazil	21 787	4 539	–	–
	Total	108 24[illegible]	18 818	50 547	11 575
72.02	Ferromanganese				
7202.11	-- Containing by weight more than 2% of carbon				
7202.11.10	---Containing by weight not more than 1% of silicon				
7202.11.10.10	----- Containing by weight more than 2% but not more than 3% of carbon				
	United States	43	22	150	67
	Total	43	22	150	67
7202.11.10.20	-- Containing by weight more than 3% of carbon				
	South Africa	10 871	5 101	7 020	4 458
	United States	2 336	1 493	1 362	1 002
	France	6	24	–	–
	Total	13 213	6 619	8 382	5 460
7202.11.20	---Containing by weight more than 1% of silicon				
7202.11.20.10	----- Containing by weight more than 2% but not more than 3% of carbon				
	United States	52	37	24	23
	Total	52	37	24	23
7202.11.20.20	----- Containing by weight more than 3% of carbon				
	United States	152	111	95	46
	South Africa	21	11	–	–
	Total	173	122	95	46

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
7202.19	-- Other ferromanganese				
7202.19.10	--- Containing by weight not more than 1% of silicon				
7202.19.10.10	----- Containing by weight not more than 0.75% of carbon				
	France	106	185	1 808	3 529
	Norway	2 611	2 338	1 065	1 742
	United States	1 063	907	818	935
	Spain	2 472	3 578	447	875
	Total	6 252	7 009	4 138	7 082
7202.19.10.20	----- Containing by weight more than 0.75% but not more than 2% of carbon				
	South Africa	–	–	6 512	7 313
	West Germany	5 573	6 114	4 700	5 971
	Norway	1 628	1 448	5 727	5 513
	Other countries	3 602	3 607	1 061	1 318
	Total	10 803	11 169	18 000	20 115
7202.19.20	--- Containing by weight more than 1% of silicon				
7202.19.20.10	----- Containing by weight not more than 0.75% of carbon				
	United States	51	90	196	476
	Total	51	90	196	476
7202.19.20.20	----- Containing by weight more than 0.75% but not more than 2% of carbon				
	United States	57	52	937	710
	Norway	–	–	95	142
	Brazil	2 516	1 376	–	–
	South Africa	1 900	817	–	–
	Total	4 473	2 246	1 032	852
7202.30.00	- Ferro-silicomanganese				
	South Africa	6 347	4 401	5 166	4 534
	United States	5 476	4 936	2 479	2 236
	Brazil	5 009	3 290	2 012	2 088
	Other countries	309	198	44	60
	Total	17 141	12 825	9 701	8 918
8111.00.10	Unwrought manganese, not alloyed; powders, not alloyed				
8111.00.10.10	----- Unwrought manganese				
	United States	530	1 125	620	1 560
	People's Republic of China	–	–	67	136
	South Africa	528	1 392	20	56
	Total	1 058	2 517	707	1 754

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
8111.00.10.20	----- Powders				
	South Africa	1 697	3 878	2 499	5 776
	United States	27	70	52	149
	Total	1 724	3 948	2 551	5 926
8111.00.20	Unwrought manganese, alloyed; waste and scrap; powders, alloyed; articles of manganese				
8111.00.20.10	----- Unwrought manganese				
	United States	602	1 609	542	1 643
	France	–	–	35	80
	United Kingdom	–	–	10	24
	Total	602	1 609	587	1 749
8111.00.20.20	----- Manganese waste and scrap				
	United States	...	...	49	50
	Zaire	1	10	–	–
	Total	1	10	49	50
8111.00.20.30	----- Manganese powders				
	United States	8	25	8	27
	Total	8	25	8	27
8111.00.20.40	----- Articles of manganese				
	United States	477	2 400	76	974
	United Kingdom	238	657	148	391
	Other countries	10	210	9	55
	Total	725	3 267	233	1 420
Exports					
7202.11	Ferromanganese, containing by weight more than 2% of carbon				
	United States	24 141	10 294	7 634	4 059
	Japan	–	–	1 500	492
	Total	24 141	10 294	9 134	4 552
7202.19	Ferromanganese, n.e.s.				
	United States	1 649	964	585	157
	Philippines	–	–	3	9
	Total	1 649	964	588	167
7202.30	Ferro-silicomanganese				
	United States	55	78	1 589	1 594
	Brazil	10	33	–	–
	Total	65	111	1 589	1 594

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
8111.00	Manganese and articles thereof, including waste and scrap				
	United States	359	448	709	1 453
	Other countries	. . .	1	–	–
	Total	359	449	709	1 453

	1986	1987	1988p
		(tonnes)	
Consumption[1]			
Manganese ore	199 699r	220 053	160 146

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Available data as reported by consumers.
p Preliminary; r Revised; – Nil; . . . Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, MANGANESE IMPORTS, EXPORTS AND CONSUMPTION, 1970, 1975, 1980–89

	Imports			Exports	Consumption[2]	
	Manganese Ore[1]	Ferro-manganese	Ferro-silico-manganese	Ferro-manganese	Ore	Ferromanganese and Silicomanganese
			(gross weight, tonnes)			
1970	115 052	17 891	975	510	153 846	97 952
1975	69 773	35 701	5 732	1 168	160 976	95 869
1980	95 161	26 704	20 901	11 278	157 680	95 796
1981	119 748	36 656	12 669	57 040	288 906	83 886
1982	71 658	25 088	2 877	11 739	130 826	69 166
1983	42 260	18 263[r]	416[r]	2 631	96 697	86 111
1984	77 543	29 797[r]	6 823[r]	9 196[r]	109 913[r]	95 049
1985	102 199[r]	27 481[r]	6 601	43 408[r]	160 241	93 994
1986	94 914	20 283[r]	6 773	45 090	199 699[r]	86 687
1987	80 957	39 606	13 301	23 103	220 053	112 868
1988[p]	108 413	35 060	17 141	25 790	160 146	112 676
1989[e]	135 000	36 000	16 000	24 500	190 000	105 000

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Mn content. [2] Available data as reported by consumers.

[p] Preliminary; [r] Revised; [e] Estimated.

TABLE 3. WORLD PRODUCTION OF MANGANESE ORES, 1988 AND 1989 AND RESERVES, 1987

	Mn	Ore Production		Reserves[2]
		1988[p]	1989[e]	1987[e]
	(%)		(000 tonnes)	
U.S.S.R.	24-33	10 300	11 000	325 000
Republic of South Africa	30-48 +	3 500	3 700	407 000
Brazil	38-50	2 800	2 950	20 900
Gabon	50-53	2 650	2 650	110 000
Australia	37-53	2 060	2 090	75 000
People's Republic of China[e]	20 +	1 760	1 760	15 000
India	10-54	1 450	1 490	20 000
Mexico	27 +	470	500	3 700
Other countries[1]	. .	850	1 125	. .
Total	. .	25 840	27 265	976 600

Source: Energy, Mines and Resources Canada and U.S. Bureau of Mines, "Mineral Commodities Summaries", 1989.

[1] Includes countries, each producing less than 24 000 t/y. [2] Mineable reserves.

[p] Preliminary; [e] Estimated; . . Not available.

TABLE 4. WESTERN WORLD CONSUMPTION OF MANGANESE FERROALLOYS, 1985-89

Region	1985	1986	1987	1988	1989
			(000 t Mn content)		
North America	440	360	409	446	420
Asia	660	663	730	783	785
Western Europe	1 098	996	915	921	978
Latin America	172	189	197	199	215
Other	218	176	170	190	175
Total	2 588	2 384	2 421	2 539	2 573

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries; Resource Strategies Inc., Manganese Industry Analysis, February 1989; Roskill Economics of Manganese, 1989.

TABLE 5. WESTERN WORLD PRODUCTION OF MANGANESE FERROALLOYS, 1985-89

Region	1985	1986	1987	1988	1989
			(gross weight, 000 t)		
North America	222	217	213	252	260
Asia	954	1 221	1 106	926	1 120
Western Europe	934	926	826	932	870
Latin America	350	376	377	374	395
Norway	504	425	433	437	490
South Africa	584	624	611	640	675
Other	222	230	242	250	225
Total	3 770	4 019	3 808	3 811	4 035

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries; Resource Strategies Inc., Manganese Industry Analysis, February 1989; Roskill Economics of Manganese, 1989.

Mineral Aggregates

1989

O. Vagt

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After general economic recovery from the 1982-84 period of recession, construction expenditures relating to residential building expanded rapidly. The commercial and institutional sectors expanded more slowly, and engineering construction expenditures, with gas and oil accounting for up to one third, were relatively low until a broader upturn began in 1988. This trend continued in 1989. Although housing starts turned slightly weaker, they were higher than forecast for most regions.

Demand for mineral aggregates tends to be local, reflecting trends in domestic construction, although international bulk shipping is becoming important in some areas. In the case of non-residential construction, there was general stability since late 1988, with an increase of 2.5% in the third quarter of 1989. Total aggregate production over the past three years has been in excess of 350 Mt/y. Average unit prices have not changed greatly and differ between provinces depending on proximity to consuming centres. Housing starts, a fair indicator of demand for construction materials, rose to 245 986 in 1987, decreased to 222 562 in 1988 and were about 215 000 in 1989. Total construction expenditures are expected to exceed $95 billion.

Federal/provincial programs to assess aggregate resources and future market requirements were mainly concluded. Some of these were undertaken as part of Mineral Development Agreements under the Economic and Regional Development Agreements (ERDAs) between the levels of government. Although awareness of the importance of mineral aggregates for construction and the consumer is increasing, inherent constraints to expanding reserves persist because property owners generally oppose the opening of nearby quarries or gravel pits. In the case of Ontario, a new Planning Act addresses the non-renewable resource aspect, emphasizing that thorough long-term planning should be pursued at the provincial level, thus helping to assure compatibilities in land use.

CANADIAN DEVELOPMENTS

Sand and Gravel

Sand and gravel deposits are widespread and large producers have established "permanent" plants as convenient as possible to major consuming centres. In addition to large aggregate operations usually associated with other construction-related activities such as ready-mix or asphalt plants, many small producers active on a seasonal or part-time basis serve local markets. Even relatively large operations may operate intermittently serving, when required, as a supply arm for a heavy construction company. Provincial departments of Highways operate regional or divisional quarries supplying roadbed material for new and repair work. Varied exploitation by a wide range of groups has resulted in obstacles to the collection of accurate production and consumption data concerning sand, gravel and stone.

Crushed Stone

Many stone-producing operations are part-time or seasonal; others are operated as subsidiaries of construction or manufacturing establishments not classified to the stone industry. Also, some are operated by municipal or provincial government departments producing stone for their own direct use. Quarries removing rock by drilling, blasting and crushing generally are not operated for small, local needs as often occurs in the case of gravel pits. Rather, these operations are generally associated with large construction-related companies. Depending on costs and availability, crushed stone competes with gravel and crushed gravel as an aggregate in concrete and asphalt, and as railway ballast and road metal. In these applications, it is subject to the same physical and chemical-testing procedures as the gravel and sand aggregates.

Steetley Quarry Products Inc. continued its expansion and modernization program at the Dundas quarry near Hamilton, Ontario. This operation is the second largest in Canada, producing about 3.5 Mt/y. The leading producer is

Dufferin Aggregates, near Milton, Ontario, with about 7.5 Mt/y, according to a recent survey by Rock Products.

Gormley Aggregates Ltd., of Gormley, Ontario, which operates two quarries and seven sand and gravel plants in southern Ontario, was taken over by Lake Ontario Cement Limited, a subsidiary of Société des Ciments Français of France.

Quarrying operations to supply high-quality construction aggregates or high-quality chemical stone have been successful on the east and west coasts where large-volume ocean transportation facilities may be used to reduce unit transportation costs. Producers of high-calcium limestone on Texada Island in British Columbia have supplied Vancouver and Washington State cement and lime producers with raw material for many years. Construction aggregate from the Strait of Canso area in Nova Scotia has been barged to many Atlantic Canada areas and, in the last few years, it has been shipped in 50 000-60 000 t loads as far as Houston, Texas.

The Newfoundland Resources & Mining Company Limited, owned by Explaura Holdings PLC of the United Kingdom, continued development of its limestone aggregate operation on the Port-au-Port Peninsula, Newfoundland. More than 90 000 t were crushed for stockpiling prior to large-scale bulk shipments mainly to U.S. markets. Plans are to increase shipments up to 4-5 Mt/y in three to five years.

Municipal Ready Mix Ltd. of Sydney, Nova Scotia, announced plans for a major marine quarry to be situated on deep water at Kelly's Mountain, about 40 km north of the city. Plans centre on producing 4-5 Mt/y of granite aggregates mainly to serve eastern seaboard markets in the United States.

WORLD DEVELOPMENTS

Very large-scale on-shore "marine" quarrying of regular aggregates to serve international markets has attracted considerable interest in Great Britain, Europe, the United States and Canada. The approach was pioneered in 1986 by Foster Yeoman Ltd. at its Glensanda quarry on the west coast of Scotland, recently followed by Vulcan Materials Co.'s joint venture on the Yucatan Peninsula, Mexico.

The trend in international investments continued, particularly by British companies in North America and Europe. Major companies involved include: Tarmac plc, RMC Group plc, Redland plc, C.H. Beazer, English China Clays plc, Alfred McAlpine, Blue Circle Industries Ltd., BTR Ltd., Hanson PLC, Consolidated Gold Fields PLC and Wimpey Construction Ltd. The potential for corporate growth in countries characterized by less concentration, along with opportunities to diversify geographically because of the cyclical nature of construction, is seen as an important motivating factor for these developments.

Offshore dredging projects have become more important in recent years as a result of the strong demand for aggregates and more on-land environmental and zoning constraints. This is particularly true in the United States, and also in Japan where seabed sands account for about 40% of the total domestic production of fine aggregates necessary for concrete.

Lightweight Aggregates

Four categories generally used to classify the lightweight aggregates combine elements of source, processing methods and end-use. Natural lightweight aggregates include materials such as pumice, scoria, volcanic cinders and tuff. Manufactured lightweights are bloated or expanded products obtained by heating certain clays, shales and slates. Ultra-lightweights are made from natural mineral ores, such as perlite and vermiculite, which are expanded or exfoliated by the application of heat and used mainly for insulation and horticultural needs. Fly ash obtained from the combustion of coal and coke and slag resulting from metallurgical processes are classed as by-product aggregates.

Perlite: Perlite is a variety of glassy volcanic rock (obsidian) that contains 2-6% of chemically combined water. When the crushed rock is heated rapidly to 760-980°C, expansion occurs between 4 and 20 times its original volume. With attention being given to pre-blending of feed to the kiln and retention time in the kiln, expanded material can be manufactured to weigh as little as 30-60 kg/m^3.

In Canada, imported perlite is expanded and used mainly for fibre-perlite construction products, where its value as a lightweight material is augmented by its fire-resistant qualities. It is also used as a loose insulation and as an insulating medium in concrete products. Perlite, vermiculite and expanded shale and clay are becoming more widely used in agriculture as soil conditioners and fertilizer carriers.

Imports of crude perlite for consumption in Canada are from New Mexico and Colorado deposits, worked by companies including Grefco, Inc., Manville Corporation, USG Corporation and United Perlite Corp.

A perlite processing plant in Surrey, British Columbia, operated by an associate of Aurun Mines Ltd., produced horticultural grades from imported raw material. With improved markets for a wider range of grades there is optimism that high-quality domestic sources will be used in the future.

Pumice: In Canada, a number of concrete products manufacturers use pumice imported from Greece or from the northwestern United States, mainly in the manufacture of concrete blocks. A major potential use for pumice in Canada relates to highway surfacing whereby exceptional skid resistance is imparted by the angular faces of this aggregate.

Vermiculite: The term "vermiculite" refers to a group of micaceous minerals, hydrous magnesium-aluminum silicates, that exhibits a characteristic lamellar structure and expands or exfoliates greatly when heated rapidly. Canadian consumption is mainly for horticulture with lesser amounts for insulation and miscellaneous uses.

The United States is the major producer, and the leading supplier to Canada is W.R. Grace and Company, from operations at Libby, Montana and the Enoree region of South Carolina. Canada also imports crude vermiculite from the Republic of South Africa, where Palabora Mining Co. Ltd. (PMC) is the major producer. Vermiculite occurrences have been reported in British Columbia, and deposits near both Perth and Peterborough in Ontario have been investigated.

Clay, shale and slag: Common clays and shale are used throughout Canada for manufacturing lightweight aggregates. Although the Canadian industry began in the 1920s in Ontario, it did not evolve significantly until the 1950s when it grew in support of demand from the construction industry. Raw materials are usually quarried adjacent to the plant sites. Clays receive little beneficiation other than drying before introduction to the kiln where they are heated to promote expansion. Shales are crushed and screened before burning.

In steel-making, iron ore, coke and limestone flux are melted in a metallurgical process. When completed, lime is combined with the silicates and aluminates of the ore and coke, forming slag, a nonmetallic product. After controlled cooling from the molten state, the porous, glassy slag may be crushed and sized for many construction-related applications.

Ongoing research sponsored through CANMET and relating to supplementary cementing materials led to the successful use of blast furnace slag for manufacturing a slag cement. Reiss Lime Company of Canada, Limited is now producing this type of cement from a grinding plant at Spragge, Ontario, using granulated slag from The Algoma Steel Corporation, Limited's, Sault Ste. Marie plant. Plant capacity is 200 000 t/y of slag cement for complete or partial replacement of Portland cement, depending on requirements. The primary use at present is in mine backfill; however, construction-related uses are also being investigated.

PRICES

There are no standard prices for sand, gravel and crushed stone. In addition to supply-demand factors, prices are determined regionally, or even locally, by production and transportation costs, by the degree of processing required for a given end use and by the quantity of material required for a particular project.

USES

The principal uses for sand and gravel are in highway construction and as concrete aggregate. Individual home construction triggers the need for about 300 t of aggregate per unit, while apartment construction requires only about 50 t per unit, according to an Ontario Ministry of Natural Resources study.

The construction industry utilizes 95% of total stone output as crushed stone mainly as an aggregate in concrete and asphalt, in highway and railway construction and as heavy riprap for facing wharves and breakwaters. Specifications vary greatly depending on the intended use, and many tests are required to determine the acceptability of aggregates for certain applications. Particle size distribution of aggregates, as assessed by grading tests or sieve analysis, affects the uniformity and workability of a concrete mix as well as the strength of the concrete, the density and strength of an asphalt mix, and the durability, strength and stability of the compacted mass when aggregates are used as fill or base-course material. Also of importance are tests to determine the presence of organic impurities or other deleterious material, the resistance of the aggregate to abrasion and to freeze-thaw cycles, the effects of thermal expansion, absorption, porosity and reactivity with associated materials and surface texture.

The use of lightweight concrete in commercial and institutional projects has facilitated the construction of taller buildings and the use of longer, clear spans in bridges and buildings. Additional advantages from the use of lightweight aggregates lie in the fact that they supply thermal and acoustical insulation, fire resistance, good freeze-thaw resistance, low water absorption and a degree of toughness to the concrete product.

There are, as yet, no Canadian Standards Association (CSA) specifications for the lightweight aggregates. Production and application are based on the American Society for Testing and Materials (ASTM) designations as follows: ASTM Designations C 332-676 - Lightweight Aggregates for Insulating Concrete; C 330-75a - Lightweight Aggregates for Structural Concrete; and C 331-69 - Lightweight Aggregates for Concrete Masonry Units.

OUTLOOK

Economic activity is expected to remain firm in 1990 partially based on residential and non-residential construction, higher oil prices than during the 1986 low, and more overall spending in anticipation of the goods and services tax. Projections in late 1989 by the Conference Board of Canada suggest that the gross domestic product will expand 1.9% in 1990 and 1.7% in 1991. Housing starts are expected to weaken in central Canada with starts nationwide decreasing to a more sustainable level of about 200 000 in 1990. Energy-related investments are expected to continue their recovery and this will broaden construction in western Canada. Megaprojects such as Hibernia, if full approvals are given, are expected to provide a boost to the energy sector beginning in 1990-91.

The Canadian Construction Association predicts growth in constant dollar expenditures of about 4% through the 1989-91 period in the non-residential contract construction industry.

Production and sales of aggregates in the northeastern United States and in the mid-Atlantic region are expected to decline slightly or be flat according to one major survey. Reasons given relate to the previous period of residential and commercial over-building, rising interest rates and some political impasses over highway funding.

Urban expansion has greatly increased demand for aggregates in support of major construction. Paradoxically, urban spread has not only tended to overrun operating pits and quarries, but has extended into areas containing potentially valuable reserves. Further complications have arisen in recent years as society has become increasingly aware of environmental problems, thus emphasizing that operators may face additional constraints when expanding or establishing new plants. Clearly, municipal and regional zoning must be designed to regulate toward the best utilization of resources - along with site rehabilitation - to ensure optimal sequential land use.

Sand and gravel will continue to be competitive with crushed stone in many areas and, in some applications, with lightweight aggregates. New reserves must be located and assessed as part of the community planning or regional zoning process. Prices for aggregates will continue to rise with increasing land values, more sophisticated operating techniques and equipment, the depletion of more-accessible reserves and added rehabilitation expenditures.

Estimates have indicated that available sand and gravel supplies in some regions will be depleted by the 1990s making outlying deposits necessary for the needs of the construction industry. Predicted shortages could encourage exploitation of offshore deposits and even underground mining in some regions.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, TOTAL PRODUCTION OF STONE, 1987-89

	1987		1988		1989^{p}	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province[1]						
Newfoundland	1 041	9 303	1 023	7 248	590	4 707
Nova Scotia	5 015	24 963	6 567	34 453	6 416	33 747
New Brunswick	2 999	16 676	2 445	15 266	2 250	13 614
Quebec	44 440	217 766	46 450	234 775	42 206	220 639
Ontario	61 966	294 665	58 460	313 141	56 870	316 068
Manitoba	4 393	18 116	2 877	12 537	3 041	14 076
Saskatchewan	2	4	–	–	–	–
Alberta	1 940	7 720	528	3 350	282	2 762
British Columbia	6 496	34 234	3 571	21 264	4 830	26 364
Northwest Territories and Yukon	677	2 165	108	232	172	622
Total	128 969	625 613	122 030	642 267	116 657	632 599
By use[2]						
Dimensional stone						
Rough	187	15 047	..	..	..	..
Monumental and ornamental stone (n.f.)	62	7 043	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	30	2 776	..	..	..	..
Chemical and metallurgical						
Cement plants, Canada	12 543	26 300	..	..	..	..
Cement plants, foreign	726	1 911	..	..	..	..
Lining, open-hearth furnaces	–	–	..	..	..	..
Flux in iron and steel furnaces	1 192	4 663	..	..	..	..
Flux in nonferrous smelters	–	–	..	..	..	..
Glass factories	196	3 509	..	..	..	..
Lime plants, Canada	3 134	16 271	..	..	..	..
Lime plants, foreign	585	2 221	..	..	..	..
Pulp and paper mills	263	1 962	..	..	..	..
Sugar refineries	45	223	..	..	..	..
Other chemical uses	847	5 798	..	..	..	..

TABLE 1. (cont'd)

	1987		1988		1989[p]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Pulverized stone						
Whiting (substitute)	–	–	. .	. .	. .	. .
Asphalt filler	–	–	. .	. .	. .	. .
Dusting, coal mines	–	–	. .	. .	. .	. .
Agricultural purposes and fertilizer plants	1 393	16 437	. .	. .	. .	. .
Other uses	446	14 691	. .	. .	. .	. .
Crushed stone for						
Manufacture of artificial stone	–	–	. .	. .	. .	. .
Roofing granules	401	7 862	. .	. .	. .	. .
Poultry grit	–	–	. .	. .	. .	. .
Stucco dash	23	1 506	. .	. .	. .	. .
Terrazzo chips	–	–	. .	. .	. .	. .
Rock wool	–	–	. .	. .	. .	. .
Rubble and riprap	1 840	10 112	. .	. .	. .	. .
Concrete aggregate	11 589	59 728	. .	. .	. .	. .
Asphalt aggregate	9 459	47 297	. .	. .	. .	. .
Road metal	52 951	233 462	. .	. .	. .	. .
Railroad ballast	5 972	33 094	. .	. .	. .	. .
Other uses	25 086	113 698	. .	. .	. .	. .
Total	128 969	625 613	. .	. .	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada

[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.

[p] Preliminary; . . Not available; – Nil; n.f. Not finished or dressed.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, PRODUCTION OF SAND AND GRAVEL BY PROVINCE, 1987-89

	1987^r		1988		1989^p[1]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	3 319	16 451	5 370	18 668	5 096	17 479
Prince Edward Island	673	2 541	922	2 138	848	2 177
Nova Scotia	8 334	24 368	9 483	27 726	7 982	23 651
New Brunswick	11 056	X	9 429	18 291	9 039	15 228
Quebec	36 460	X	37 590	99 146	33 877	98 972
Ontario	96 250^r	295 919^r	104 838	336 156	96 699	329 649
Manitoba	14 687	39 264	14 189	45 158	14 438	41 930
Saskatchewan	11 922	33 619	12 239	33 043	10 636	30 633
Alberta	44 050	137 523	42 361	141 504	43 679	134 642
British Columbia	49 260	131 316	48 658	123 233	50 395	127 181
Yukon and Northwest Territories	2 906^r	10 865^r	4 683	16 150	4 434	16 264
Total Canada	278 916^r	785 180^r	289 763	861 214	277 122	837 806

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Production values for silica have been included in sand and gravel.

^{p} Preliminary; X Confidential; ^{r} Revised.

Note: Totals may not add due to rounding.

TABLE 3. AVAILABLE DATA ON CONSUMPTION OF SAND AND GRAVEL, BY PROVINCE, 1986 AND 1987

		Atlantic Provinces	Quebec	Ontario	Western Provinces[1]	Canada
				(000 tonnes)		
Roads	1986	14 032	17 522	46 348	83 243	161 145
	1987	16 735	21 379	50 819	86 746	175 678
Concrete aggregate	1986	1 703	4 179	17 574	11 347	34 803
	1987	2 175	5 709	19 231	12 190	39 304
Asphalt aggregate	1986	1 553	2 876	5 081	9 398	18 908
	1987	2 140	3 101	6 193	10 029	21 463
Railroad ballast	1986	372	130	123	2 430	3 055
	1987	110	. . .	284	2 171	2 565
Mortar sand	1986	86	269	1 583	356	2 294
	1987	100	452	2 235	377	3 165
Backfill for mines	1986	28	936	1 043	592	2 599
	1987	26	418	698	472	1 615
Other fill	1986	1 613	3 497	13 896	8 124	27 130
	1987	1 984	5 357	15 085	9 004	31 430
Other uses	1986	328	198	2 018	5 198	7 742
	1987	113	44	1 706	1 834	3 696
Total sand and gravel	1986	19 716	29 607	87 666	120 689	257 677
	1987	23 382	36 460	96 250	122 825	278 916

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] The western provinces include the Yukon and Northwest Territories.

. . . Amount too small to be expressed.

Note: Totals may not add due to rounding.

TABLE 4. CANADA, EXPORTS AND IMPORTS OF SAND AND GRAVEL AND CRUSHED STONE, 1988 AND 1989

		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
2505.90	Natural sands n.e.s., excluding metal bearing sands				
	United States	210 137	1 571	10 978	260
	Other countries	3 783	123	25	26
	Total	213 920	1 697	11 003	288
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.				
	United States	1 573 698	9 726	941 603	7 468
	Other countries	130 841	1 456	48 617	953
	Total	1 704 539	11 187	990 220	8 425
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement				
	United States	1 106 772	5 912	608 048	3 182
	Other countries	169	83	23	5
	Total	1 106 941	5 997	608 071	3 187
Imports					
2505.90	Natural sands n.e.s., excluding metal bearing sands				
	United States	459 482	5 536	659 291	6 506
	Other countries	178	14	271	22
	Total	459 661	5 552	659 562	6 530
2517.10	Pebbles, gravel, broken or crushed stone used for aggregates, etc.				
	United States	599 739	3 598	593 190	3 401
	Other countries	-	-	815	10
	Total	599 739	3 598	594 005	3 413
2521.00	Limestone flux; limestone and other calcareous stone used for lime or cement				
	United States	2 640 893	9 534	2 417 529	8 897
	Other countries	94	. .	46	. .
	Total	2 640 987	9 534	2 417 575	8 898

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; . . Not available; n.e.s. Not elsewhere specified; - Nil.
Note: Totals may not add due to rounding.

TABLE 5. LIGHTWEIGHT AGGREGATE PRODUCERS IN CANADA, 1988

Company	Location	Commodity	Remarks
Atlantic Provinces			
Annapolis Valley Peat Moss Company Limited	Berwick, N.S.	Vermiculite	Processed for use in horticulture.
Avon Aggregates Ltd.	Minto, N.B.	Expanded Shale	Processed for concrete products industry.
Fisons Western Corporation	Maisonnette, N.B.	Perlite	Processed for use in horticulture.
Quebec			
Armstrong World Industries Canada Ltd.	Gatineau	Perlite	Processed for use in ceiling tile manufacture.
Premier Peat Moss Ltd.	Rivière du Loup	Perlite, Vermiculite	Processed for use in horticulture.
Ontario			
CGC Inc.	Hagersville	Perlite	Processed for use in gypsum plaster.
National Slag Limited	Hamilton	Slag	Used in concrete blocks and as slag cement.
W.R. Grace & Co. of Canada Ltd.	St. Thomas	Vermiculite	Vermiculite processed for use in horticulture and as loose insulation.
	Ajax	Vermiculite, Perlite	Perlite processed for use in gypsum plaster, in horticulture, refractories, as loose insulation, in friction materials and in fireproofing.
Prairie Provinces			
Apex Aggregate	Saskatoon, Sask.	Expanded clay	Processed for concrete block manufacture.
Cindercrete Products Limited	Regina, Sask.	Expanded clay	Processed for concrete products industry.
Consolidated Concrete Limited	Calgary, Alta.	Expanded shale	Processed for concrete products industry.
CBR Cement Canada Limited	St. Albert, Alta.	Expanded clay	Processed for concrete products industry.
Fisons Western Corporation	Elma, Man. Seba Beach, Alta.	Perlite Perlite	Processed for use in horticulture. Processed for use in horticulture.
Kildonan Concrete Products Ltd.	Winnipeg, Man.	Expanded clay	Processed for concrete products industry.
W.R. Grace & Co. of Canada Ltd.	Winnipeg, Man.	Vermiculite, Perlite	Perlite processed for use in gypsum plaster and in horticulture.
	Edmonton, Alta.	Vermiculite, Perlite	Vermiculite processed for use in horticulture and as loose insulation.
British Columbia			
Ocean Construction Supplies Limited	Vancouver	Pumice	Purchased for concrete products industry.
Pacific Perlite Joint Venture	Surrey	Perlite	Processed mainly for use in horticulture.
W.R. Grace & Co. of Canada Ltd	Vancouver	Vermiculite, Perlite	Processed mainly for use in horticulture.

TABLE 6. CANADA, IMPORTS OF VERMICULITE, PERLITE AND PUMICE, 1988 AND 1989

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
2513.11	Pumice stone: crude or in irregular pieces, including crushed pumice				
	United States	2 777	1 375	1 138	631
	Greece	23	15	4 431	170
	Other countries	217	103	433	230
	Total	3 017	1 493	6 002	1 031
2513.19	Pumice stone: other				
	United States	1 825	1 192	1 196	819
	Ecuador	52	26	75	41
	Italy	328	174	68	39
	Other countries	486	288	70	65
	Total	2 691	1 680	1 409	964
2530.10.10.10	Vermiculite, unexpanded				
	United States	14 510	2 591	15 800	2 595
	South Africa	7 115	1 021	8 829	1 269
	Brazil	-	-	1 090	154
	Total	21 625	3 612	25 719	4 019
2530.10.10.20	Perlite, unexpanded				
	United States	14 419	1 784	15 021	1 804
	Greece	1 549	116	3 173	239
	Mexico	154	22	-	-
	Total	16 122	1 923	18 194	2 044
3802.90.20	Activated perlite, excluding perlite ground to be employed in filtering				
	United States	1 768	854	615	302
6806.20.00.10	Exfoliated (expanded) vermiculite				
	United States	271	304	160	357
6806.20.00.20	Expanded perlite				
	United States	1 086	784	877	1 053
	Austria	-	-	22	46
	Total	1 086	784	899	1 100

Source: Statistics Canada.
p Preliminary; - Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 7. CANADA, LIGHTWEIGHT AGGREGATES PRODUCED, SOLD AND USED, 1987 AND 1988

	1987				1988[2]			
	Produced		Sold and Used		Produced		Sold and Used	
	(m³)	($)	(m³)	($)	(m³)	($)	(m³)	($)
From domestic and or imported raw materials								
Expanded clay, shale and slag[1]	370 629	8 939 088	344 612r	7 937 297r	316 001	7 272 541	304 981	6 771 808
From imported crude materials								
Expanded perlite and exfoliated vermiculite[1]	340 086	14 146 142	339 459r	14 114 725r	436 800	19 501 341	436 236	19 471 646
Total	710 715	23 085 230	684 071r	22 052 022r	752 801	26 773 882	741 217	26 243 454

Source: Company data. See Table 5 for list of establishments surveyed.
[1] Combined to avoid disclosing confidential company data. [2] Increase in number of companies being surveyed.
r Revised.

TABLE 8. CANADA, SALES OF SLAG, PERCENTAGE BY END-USE, 1986-88

Use	1986	1987	1988
Concrete block manufacture	29.0	38.3	38.3
Ready-mix concrete	3.0	3.8	3.8
Loose insulation	1.0	-	-
Slag cement	67.0	55.4	55.4
Precast concrete manufacture	-	2.5	2.5

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.
- Nil.

TABLE 9. CANADA, SALES OF EXPANDED CLAY AND SHALE, PERCENTAGE BY END-USE, 1986-88

Use	1986[r]	1987[r]	1988
Concrete block manufacture	80.8	79.2	86.3
Precast concrete manufacture	5.2	3.5	3.6
Ready-mix concrete	6.4	6.0	3.8
Horticulture and miscellaneous uses	7.6	11.3	6.3

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.
[r] Revised.

TABLE 10. CANADA, SALES OF EXPANDED PERLITE, PERCENTAGE BY END-USE, 1986-88

Use	1986	1987[r]	1988
Insulation			
in gypsum products	14.4	8.2	2.7
in other construction materials	33.3	37.8	31.1
Horticulture and agriculture	36.6	42.4	56.1
Loose insulation and miscellaneous uses	15.7	11.6	10.1

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.
[r] Revised.

TABLE 11. CANADA, SALES OF EXPANDED VERMICULITE, PERCENTAGE BY END-USE, 1986-88

Use	1986	1987[r]	1988
Insulation			
loose	21.6	13.0	12.6
in concrete and concrete products	-	-	-
in gypsum products	-	-	-
Horticulture	53.5	47.0	61.5
Miscellaneous uses	24.9	40.0	25.9

Source: Company data. See Table 5 for list of establishments surveyed. Sales also imply quantities consumed for own use.
- Nil; [r] Revised.

TABLE 12. CANADA, VALUE OF CONSTRUCTION BY TYPE[1], 1987-89

	1987	1988	1989
		($ millions)	
Building Construction[2]			
Residential	35 825	38 660	39 295
Industrial	3 244	3 560	3 678
Commercial	12 378	13 579	14 289
Institutional	4 314	4 512	4 967
Other building	2 147	1 415	2 848
Total	57 908	62 727	65 078
Engineering Construction[2]			
Marine	317	489	637
Highways, airport runways	5 433	5 633	5 987
Waterworks, sewage systems	2 304	2 920	3 333
Dams, irrigation	307	311	369
Electric power	3 616	4 824	5 616
Railway, telephones	2 922	3 051	3 475
Gas and oil facilities	6 030	7 450	7 447
Other engineering	3 135	3 310	3 255
Total	24 064	27 989	30 119
Total construction	81 971	90 715	95 197

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Actual expenditures 1987, preliminary actual 1988, intentions 1989. [2] Includes total value of new and repair work purchased.

TABLE 13. CANADA, VALUE OF CONSTRUCTION BY PROVINCE[1], 1987–89

	1987			1988			1989		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
				($ millions)					
Newfoundland	892	648	1 540	899	691	1 590	929	694	1 622
Nova Scotia	1 578	650	2 228	1 643	712	2 354	1 679	738	2 417
New Brunswick	1 214	457	1 671	1 306	452	1 758	1 393	526	1 919
Prince Edward Island	206	76	282	241	91	333	237	99	336
Quebec	14 629	4 172	18 800	15 583	5 347	20 931	15 205	6 070	21 274
Ontario	24 754	6 343	31 097	27 112	7 291	34 403	28 806	8 186	36 991
Manitoba	2 034	926	2 960	2 038	1 022	3 060	2 122	1 204	3 326
Saskatchewan	1 880	1 506	3 386	1 949	1 808	3 757	2 086	1 724	3 810
Alberta	4 575	5 915	10 490	4 891	7 045	11 937	4 961	7 042	12 003
British Columbia, Yukon and Northwest Territories	6 146	3 371	9 517	7 065	3 528	10 593	7 662	3 836	11 498
Canada	57 908	24 064	81 971	62 727	27 989	90 715	65 078	30 119	95 197

Sources: Energy Mines and Resources Canada; Statistics Canada.

[1] Actual expenditures 1987, preliminary actual 1988, intentions 1989. [2] Includes total value of new and repair work purchased.

Molybdenum

1989

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Molybdenum production in the western world was 77.4 million kilograms (Mkg) in 1988. In the first half of 1989, production was 42.82 Mkg with total production for the year projected at 88.5 Mkg. This change represents an increase of 14.3%, due to large production increases by the secondary producers, as well as by the primary producers in North America. The United States remained the world leader in molybdenum production in 1989, with total production estimated at 49.4 Mkg, followed by Chile at 18.4 Mkg and Canada at 13.7 Mkg.

The 1989 consumption of molybdenum, estimated at 91.0 Mkg, was near the 1979 high of 95.3 Mkg. A strong performance by the steel industry, especially the stainless steel sector, was a major factor in this increase in consumption. Towards year-end, demand for steel was declining, and lower molybdenum consumption was forecasted for the coming year.

Molybdenum prices declined during the year because of the prospect of lower demand as well as increased supplies. Much of this excess supply was due to the existence of large quantities of by-product molybdenum. Many copper ore deposits in North and South America contain recoverable levels of molybdenum, and the market for copper was strong throughout the year. Thus, in spite of high consumption levels in 1988 and 1989, the market continued to be oversupplied. There is not likely to be a major increase in molybdenum prices in 1990. High inventories and excess capacity will continue to be the main factors preventing a major market recovery in the short term.

CANADIAN INDUSTRY

Canada currently has five operating mines. The Endako mine, owned by Placer Dome Inc., is the only primary producer. The other four mines producing molybdenum as a coproduct or by-product are: Brenda Mines Ltd., Gibraltar Mines Limited, Highland Valley Copper and BHP-Utah Mines Ltd.

CANADIAN DEVELOPMENTS

Canadian molybdenum production increased by 1.3% in 1989 to 13.7 Mkg. This increase is explained by the following developments:

- high output at the Endako mine, which had made considerable capital investment to increase productivity and improve quality;
- high levels of operation at Brenda Mines for the whole year; and
- supplies from by-product operations such as Utah and Endako Mines which operated at or near capacity in 1989.

The increased Canadian production occurred in spite of a prolonged strike at Highland Valley Copper, a major co-producer of molybdenum.

Since its re-opening in June 1986, Endako has been striving to become the lowest cost, primary molybdenum mine in the western world. A significant reduction in operating costs was made possible through the purchase of surplus power from the British Columbia government and the decertification of its labour unions. The Endako operation has also obtained profitable results from its molybdenum upgrading facilities. These include two roasters, with a capacity of 10 800 t/y, and a high-purity, lubricant grade molybdenum plant, which are located at the mine site. In December 1988, the company invested $2.2 million to double its ultra-pure production capacity to 450 000 kg annually. Sales of these products were good during 1989. Endako also produces chemical and catalyst grade molybdenum products on a toll basis in a leaching plant at Equity Silver Mines Limited, a subsidiary of Placer Dome.

Brenda Mines continued to operate during 1989. At its current rate of operation, ores at the present pit are expected to be depleted in mid-1990.

Hemlo Gold Mines Inc. is primarily a gold producer, but the Hemlo deposit contains 0.16% molybdenum. It also contains arsenic, antimony and mercury, which are contaminants that stay with the molybdenum when the molybdenum-bearing ore is concentrated. The company continued to experiment on processes to remove impurities from its molybdenum concentrate and a series of plant tests are scheduled for the fall of 1990. Alternative technologies receiving favourable attention include controlled roasting and leaching to remove the impurities from the molybdenum concentrate. The recovery circuit, which is expected to become fully operational by 1991, is capable of producing between 1000 and 1500 t/y at capacity. The company has found that the grade of molybdenum increases at depth, with lower concentrations of impurities.

At the Highland Valley Copper mine, a three-year labour contract expired on June 30, 1989, and a four-month strike began on July 6. A settlement was reached and operations resumed on October 21, with return to full production by October 25. The contract provided for a 12% pay increase in the first year and a 6% increase in the second.

The daily throughput of crude ore at the Lornex and Cominco Ltd.'s mills was maintained at high levels during 1989. This high level of throughput was assisted by the softer ore at the Cominco pit. The Cominco ore currently being mined has a lower molybdenum grade than in previous years.

WORLD DEVELOPMENTS

A new association of molybdenum producers, the International Molybdenum Association, was formed in 1989. Its major purpose is the production of accurate statistical information on the industry. Membership initially comprised 10 producers, representing about 80% of world production.

In the United States, Molycorp, Inc.'s Questa mine in New Mexico was brought back into production. The reserves of this mine, which is located in northern New Mexico, are extensive. Molycorp has postponed indefinitely its plans to re-open its molybdenum roaster because mine production is not sufficient to justify its operation.

Early in the year, both the Climax Molybdenum Company and the Cyprus Minerals Company increased production to levels equivalent to an annual production of 18 Mkg and 23 Mkg, respectively. At year-end, AMAX Inc. announced that its Climax Molybdenum Company would reduce molybdenum production by 15% effective January 1, 1990. Most of this reduction will occur at its Henderson mine.

USES

Molybdenum and its compounds have a number of diverse uses. It is used as a pure metal and as an alloy additive in steel and it is used in a number of chemical compounds, including a lubricant. Approximately 90% of all molybdenum consumed in the western world is used in metallurgical applications including steel, ferrous castings, special alloys and pure molybdenum metal. The remaining 10% is used in non-metallurgical applications such as chemicals, catalysts and lubricants.

As an alloying additive in steel, molybdenum imparts hardenability, strength, toughness and resistance to corrosion and abrasion. Tool steels, stainless steels, high-strength steels, heat-resisting steels and a wide range of alloy steels are important consumers of molybdenum.

Molybdenum is an important constituent of many high performance alloys that are extremely resistant to heat, corrosion and wear. Their uses include aerospace components, chemical processing plants and high temperature furnace and foundry parts.

Molybdenum compounds have many diverse uses. Some examples are: catalysts in the petroleum refining and chemical processing industries; molybdenum orange, an important molybdenum pigment used in printing inks, dyes and corrosion resistant primers; and dry lubricant used as an oil additive. In recent years, non-metallurgical applications have been experiencing a faster growth rate than others.

New uses have been developed for molybdenum in a new generation of batteries. The lithium-molybdenum battery has more energy and power per cell volume than the conventional nickel-cadmium or alkaline units. It is superior in terms of rechargeability, charge retention and storage temperature range.

PRICES

The Canadian price for contained molybdenum in concentrate averaged $8.95/kg in 1988 and was estimated at $8.92/kg in 1989.

The producers' list price for canned molybdenum oxide was US$7.95/kg at the beginning of 1989; it increased to US$8.71/kg at mid-year, dropped back to US$7.95/kg in the fourth quarter, and closed the year at US$7.28/kg. The spot price was constantly lower, and at year-end was in a range of US$5.51-5.62/kg.

OUTLOOK

The molybdenum market is entering a period of over-supply in spite of a significant improvement in demand. Estimates by Climax Metals Company place 1989 total demand at 96 Mkg and supply at 107 Mkg. Both of these numbers are significantly higher than 1987 and 1988 demand levels of 79 Mkg and 94 Mkg and supply levels of 77 Mkg and 83 Mkg respectively. There is unlikely to be any recovery in molybdenum prices in the short or medium term.

AMAX Inc. announced in December 1989 that its subsidiary, Climax Molybdenum Company, will reduce its molybdenum production by 15% beginning January 1, 1990. This reduction will occur at its Henderson mine near Empire, Colorado.

Among the important factors contributing to excess supply are the significant loss of market share by the primary producers, the increasing dominance of the by-product producers as a result of the strong copper market and the establishment of China as an important supplier. This situation is expected to continue in 1990 and, quite likely, the year after. Climax's year-end forecasts show western world molybdenum production down 10% to 86 Mkg in 1990. In response to low prices, primary producers are expected to reduce production.

The production of molybdenum in Canada in 1990 is forecast to drop back to the 1988 level. However, Canadian supply could increase substantially by 1991 when the molybdenum circuit of the Hemlo Gold mine is brought on-stream. Canadian molybdenum producers have taken steps in recent years to significantly improve their competitiveness. This was accomplished mainly through cost-cutting measures such as lower employment costs, higher productivity and negotiations for lower hydro power rates. These changes have placed Canadian producers among the lowest cost operations in the western world, thus enabling them to survive a downward market cycle.

Note: *Information contained in this review was current as of mid-January 1990.*

PRICES

Prices in US$ per pound[1] of contained molybdenum, f.o.b. shipping point unless otherwise indicated, December 31.

	1988	1989
	($)	
By-product concentrates (MoS_2)	2.950-3.10	2.250-2.300
Molybdic oxide (MoO_3) in cans, producer list price[2]	3.650	3.350
Dealer oxide (MoO_3) in cans, min. 57% Mo	3.460-3.520	3.850-3.950
Ferromolybdenum dealer export (f.a.s. port)	4.40-4.450	3.850-3.950

Source: Metals Week.

[1] 1 pound = 0.45359237 kilograms. [2] Price quotation of AMAX Inc. and Cyprus Minerals Company, based on molybdenum content.

f.a.s. Free along ship; f.o.b. Free on board.

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
26.13	Molybdenum ores and concentrates						
2613.10	- Roasted	Free	Free	Free	11.8¢/kg on molybdenum content + 1.7%	Free	Free
2613.90	- Other	Free	Free	Free	15.8¢/kg on molybdenum content	Free	Free
2825.70	- Molybdenum oxides and hydroxides						
2825.70.10	--- Molybdenum oxides	12.5%	8%	7.5%	2.5%	5.3%	3.7%
2825.70.20	--- Molybdenum hydroxides	Free	Free	Free	2.5%	5.3%	3.7%
28.30	Sulphides; polysulphides						
2830.90	- Other						
2830.90.20	--- Molybdenum disulphide	Free	Free	Free	2.4%	6.9%	Free - 5.8%
28.41	Salts of oxometallic or peroxometallic acids						
2841.70.00	- Molybdates	9.2%	6%	5.5%	2.9% - 3.4%	6.6%	4.9%
7202.70	- Ferromolybdenum	10.2%	6.5%	6.1%	3.6%	4.9%	4.9%
81.02	Molybdenum and articles thereof, including waste and scrap						
8102.10	- Powders						
8102.10.10	--- Not alloyed	4%	Free	2.4%	11.1¢/kg on molybdenum content + 1.5%	6%	3.7%
8102.10.20	--- Alloyed	10.2%	6.5%	6.1%	11.1¢/kg on molybdenum content + 1.5%	6%	3.7%

TARIFFS (cont'd)

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
8102.91	-- Unwrought molybdenum, including bars and rods obtained simply by sintering; waste and scrap						
8102.91.10	--- Unwrought molybdenum, not alloyed	4%	Free	2.4%	11.1¢/kg on molybdenum content + 1.5%	5%	3.7%
8102.91.20	--- Unwrought molybdenum, alloyed; waste and scrap	10.2%	6.5%	6.1%	11.1¢/kg on molybdenum content + 1.5%	5%	3.7%
8102.91.20.10	---- Unwrought molybdenum	10.2%	6.5%	6.1%	11.1¢/kg on molybdenum content + 1.5%	5%	3.7%
8102.91.20.20	---- Waste and scrap	10.2%	6.5%	6.1%	11.1¢/kg on molybdenum content + 1.5%	5%	3.7%
8102.92.00	-- Bars and rods, other than those obtained simply by sintering, profiles, plates, sheets, strip and foil	10.2%	6.5%	6.1%	5.2%	8%	4.9%
8102.93	-- Wire						
8102.93.10	--- Not coated or covered	8%	5%	4.8%	5.2%	8%	4.9%
8102.93.20	--- Coated or covered	10.2%	6.5%	6.1%	5.2%	8%	4.9%
8102.99	-- Other	10.2%	6.5%	6.1%	4.4%	10%	4.9%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition, Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Customs Tariff Schedules of Japan, 1989.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

TABLE 1. CANADA, MOLYBDENUM PRODUCTION, TRADE AND CONSUMPTION, 1985-87

	1985		1986		1987	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]						
British Columbia	7 526	71 099	10 896	87 722	14 771	126 315
Quebec	326	3 260	355	2 389	-	-
Total	7 852	74 359	11 251	90 111	14 771	126 315
Exports						
Molybdenum in ores, concentrates and scrap[2]						
Belgium-Luxembourg	1 208	9 732	4 347	36 701	4 484	35 443
Japan	1 004	10 964	2 140	20 202	3 579	32 296
Netherlands	766	6 634	919	7 196	1 882	16 691
United States	471	4 392	716	7 290	1 280	13 151
Chile	547	5 432	574	4 164	942	6 303
United Kingdom	545	4 971	997	7 946	681	4 671
France	-	-	458	3 827	551	3 976
West Germany	1 014	6 457	1 101	6 345	530	3 507
South Korea	56	512	85	605	130	804
Australia	25	451	31	444	92	1 005
Sweden	-	-	-	-	61	419
Iceland	-	-	-	-	36	181
Austria	-	-	-	-	5	45
Total	5 636	49 546	11 368	94 719	14 253	118 492
Imports						
Molybdic oxide and hydroxides	187	1 878	202	2 001	193	2 112
Molybdenum in ores and concentrates (Mo content)	577	4 517	1 146	8 143	201	1 317
Ferromolydenum alloys	274	2 796	348	2 939	223	2 364

	1985[6]	1986	1987
		(kilograms)	
Consumption[3] (Mo content)			
Carbon steel	. .	59 845	245 617[5]
Stainless steel	. .	77 087	86 818
Other steel	. .	458 233	573 811
Cast Iron	. .	33 093	24 444
Other uses[4]	. .	55 785	39 303
Total	772 301	684 043	969 993

Sources: Energy Mines and Resources Canada; Statistics Canada.

[1] Producers' shipments (Mo content of molybdenum concentrates, molybdic oxide and ferromolydenum). [2] Ores and concentrates category includes molybdenite and molybdic oxide. [3] Available data, as reported by consumers. [4] Nonferrous alloys, electrical, pigments and other uses. [5] Increase due to addition to survey of four companies in 1987. [6] Comparable consumption details not available prior to 1986.

- Nil; . . Not available.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, MOLYBDENUM PRODUCTION AND TRADE, 1988 AND 1989

Item No.		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production (shipments)[1]					
British Columbia		13 535	121 105	13 716	122 364
Total		13 535	121 105	13 716	122 364
Exports				**(Jan.-Sept.)**	
2613.10	Molybdenum concentrates, roasted				
	Japan	4 025	34 216	3 415	29 799
	Belgium	1 445	8 400	1 037	8 577
	Netherlands	906	5 486	742	5 348
	Other countries	990	5 997	1 232	7 659
	Total	7 366	54 109	6 426	51 388
2613.90	Molybdenum ores and concentrates, n.e.s.				
	Belgium	2 790	15 135	2 141	14 453
	Chile	770	5 597	1 209	10 194
	Sweden	111	390	956	9 277
	United Kingdom	749	4 999	881	3 860
	Other countries	2 186	13 644	941	5 533
	Total	6 606	39 771	6 128	43 323
2825.70	Molybdenum oxides and hydroxides				
	South Korea	38	236	-	-
	United States	12	150	-	-
	Total	50	386	-	-
2841.70	Metallic molybdates				
	United States	101	740	-	-
	United Kingdom	21	79	-	-
	Singapore	3	8	-	-
	Australia	3	10	-	-
	Total	128	839	-	-
7202.70	Ferromolybdenum				
	Philippines	-	-	15	38
	Total	-	-	15	38
8102.10	Powders, molybdenum				
	United States	92	712	. . .	0
	Total	92	712	. . .	0
8102.91	Molybdenum, unwrought including bars or rods simply sintered; waste or scrap				
	United States	31	71	. . .	1
	Total	31	71	. . .	1

TABLE 2. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
8102.93	Wire, molybdenum				
	Hungary	. . .	9	-	-
	Total	. . .	9	-	-
8102.99.00	Molybdenum and articles thereof, n.e.s.				
	United States	-	-	3	57
	Total	-	-	3	57
Imports					
2613.10	Molybdenum concentrates, roasted				
	United States	2	22	18	192
	Total	2	22	18	192
2613.90	Molybdenum ores and concentrates, n.e.s.				
	United States	163	1 216	408	3 322
	Total	163	1 216	408	3 322
2825.70.10	Molybdenum oxides				
	United States	171	1 363	108	937
	United Kingdom	16	70	-	-
	Total	187	1 434	108	937
2825.70.20	Molybdenum hydroxides				
	United States	1	7	5	58
	Total	1	7	5	58
2830.90.00.20	Molybdenum disulphide				
	United States	141	82	63	45
	Total	141	82	63	45
2841.70.00	Metallic molybdates				
	United States	79	482	188	1 218
	France	25	140	12	65
	Total	104	623	200	1 284
7207.70	Ferromolybdenum				
	Belgium	80	808	492	4 684
	Chile	126	1 071	193	1 583
	United States	98	361	112	1 067
	Other countries	41	343	91	740
	Total	345	2 586	890	8 077

TABLE 2. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
8102.10.10.00	Powders, molybdenum: not alloyed				
	United States	3	78	2	47
	Austria	. . .	3	-	-
	West Germany	. . .	1	-	-
	Total	3	82	2	47
8102.10.20.00	Powders, molybdenum: alloyed				
	United States	16	312	4	174
	Japan	5	21	-	-
	Total	21	334	4	174
8102.91.10.00	Molybdenum, unwrought, including bars or rods simply sintered; waste or scrap: not alloyed				
	United States	13	552	7	160
	Austria	. . .	3	-	-
	Total	13	555	7	160
8102.91.20.10	Unwrought molybdenum				
	United States	77	256	. . .	-
	Total	77	256	. . .	-
8102.91.20.20	Waste and scrap				
	United States	17	157	1	18
	Zaire	11	161	-	-
	Total	28	318	1	18
8102.92.00	Molybdenum profiles, plate, sheet, strip or foil, including bars and rods not simply sintered				
	United States	6	391	9	441
	Austria	1	27	-	-
	Total	6	418	9	441
8102.93.10	Wire, molybdenum: not coated or covered				
	United States	6	405	5	229
	United Kingdom	. . .	3	. . .	-
	Austria	1	50	1	45
	Belgium	. . .	31	1	23
	Total	6	490	6	299
8102.93.20	Wire, molybdenum: coated or covered				
	United States	2	213	1	52
	Austria	. . .	50	1	42
	Australia	. . .	4	-	-
		2	268	2	94

TABLE 2. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
8102.99.00	Molybdenum and articles thereof, n.e.s.				
	United States	4	302	3	114
	Austria	. . .	23	. . .	6
	Total	4	325	3	120

	1988p	1989
	(kilograms)	(kilograms)
Consumption[2] (Mo content)		
Carbon steel	202 917	. .
Stainless steel	115 423	. .
Other steel	730 505	. .
Cast iron	28 087	. .
Other uses[3]	74 741	. .
Total	1 151 673	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Producers' shipments (Mo content of molybdenum concentrates, molybdic oxide and ferromolybdenum).
[2] Available data, as reported by consumers. [3] Nonferrous alloys, electrical, pigments and other uses.
p Preliminary; . . Not available; . . . Too small to be expressed; - Nil; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 3. CANADA, MOLYBDENUM PRODUCTION, TRADE AND CONSUMPTION, 1975, 1980 AND 1983–89

			Imports		
	Production[2]	Exports[3]	Molybdic oxide[4]	Ferro-molybdenum[5]	Consumption[6]
			(kilograms)		
1975	13 323 144	15 710 300	56 400	269 281	1 436 883
1980	11 889 000	14 584 500	361 700	53 618	1 055 107
1983	10 194 000	11 284 000	141 000	34 000	555 167
1984	11 556 777	8 896 000	238 000	186 000	736 664
1985	7 852 060	5 637 000	187 000	274 076	772 301
1986	11 250 625	11 367 000	203 000	347 784	684 043
1987	14 771 252	14 253 000	193 000	233 335	969 993
1988[1]	13 535 186	14 022 055	188 903	344 815	1 151 673[p]
1989[p]	13 716 063	12 554 237[7]	126 260[7]	890 000[7]	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada; except where noted.

[1] Beginning in 1988, exports and imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Exports include H.S. classes 26.13 and 2825.70. Molybdic oxide includes H.S. classes 2613.10 and 2825.70.10. Ferromolybdenum includes H.S. class 7202.70. [2] Producers' shipments (Mo content of molybdenum concentrates, oxide and ferromolybdenum). [3] Mo content, oxides, ores and concentrates. [4] Gross weight. [5] For the year 1970-82 United States exports to Canada are reported by the U.S. Bureau of Commerce, Exports of Domestic and Foreign Merchandise (Report 410), over 50% molybdenum, and 1983-87 by Statistics Canada. [6] Mo content of molybdenum products reported by consumers. [7] Exports and Imports are January-September figures.

[p] Preliminary; . . Not available.

Nepheline Syenite and Feldspar

1989

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SUMMARY

The glass container industry is the major consumer of nepheline syenite and feldspar in North America. Again, in 1989, strong competition from plastics, aluminum and paper continued. For this reason, consumption of nepheline syenite by the glass container industry in Canada did not improve.

Demand for fillers and extenders was strong but tonnages are still very small. Consumption by the fiberglass industry was relatively good, although activity in the construction industry was considerably reduced compared with 1988. Demand for ceramic grade was reported to be flat.

Published prices which had not been increased since 1986 were increased 7.6% to 20%.

CANADIAN DEVELOPMENTS

Production

Nepheline syenite is produced in Ontario by Indusmin Division of Falconbridge Limited. The company operates two mines and two concentrating plants with an estimated combined production capacity of 800 000 t/y of finished products. Nepheline syenite is mined from two adjacent deposits located on Blue Mountain in Methuen Township, Peterborough County, 175 km northeast of Toronto. Preliminary figures indicate that shipments in 1989 were 555 728 t; this compares with 539 835 t in 1988. The nepheline syenite is upgraded to low-iron and high-iron glass grades, and to ceramic grades by primary and secondary crushing, drying, screening, high-intensity magnetic separation and pebble milling. For ultrafine grades (for use as filler in paints, plastics, etc.), the process uses air classification.

Feldspar is not produced on a large commercial scale in Canada. However, a potential producer is Bearcat Explorations Ltd. of Calgary.

Bearcat Explorations is studying the possibility to develop a pegmatite at Hellroaring Creek, 20 km southwest of Kimberley in southeastern British Columbia, for the production of several industrial minerals including feldspar, mica and silica. The objective would be to produce a feldspathic product suitable for the glass, fiberglass and ceramic industry. Mica would be sold to the drywall cement, paint and drilling mud industries, while quartz could be used in glass-making and other applications.

Brenda Mines Ltd. is also studying the possibility of developing a pegmatite for the production of feldspar, mica and silica. The deposit is located 13 km east of Lumby, British Columbia. A market study is expected to be completed in early 1990. Markets for feldspar in British Columbia would be the western provinces in Canada, the Pacific northwest states and northern California in the United States, and possibly southeast Asia.

Tantalum Mining Corporation of Canada Limited (TANCO) of Bernic Lake, Manitoba, reported that its project of recovering feldspar as a by-product of its spodumene operation had been put on hold due to unfavourable economic conditions. The feldspar, which is rich in rubidium (1.3% Rb_2O) and high in potassium (9.5% K_2O), would be particularly in demand for the manufacture of high-voltage electrical insulators that require 15% to 50% K-feldspar by weight, but also for glass and other ceramic products. Some 27 000 t of feldspar could be recovered annually.

CONSUMPTION

The primary glass and containers industries account for some 60% of nepheline syenite consumption in Canada, while ceramic products account for about 17%. The remaining 23% is used mainly by the glass fibre, paint, plastics and paper product industries.

Consumption of nepheline syenite in Canada by glass producers continued to be negatively influenced mainly by the use of metal, but also plastics and paper, by increased recycling of glass waste, and by the development of thinner glass containers. Although growth in filler and extender pigment is expected to continue at an increasing rate, tonnages of nepheline syenite consumption in these applications will remain small for many years.

On the positive side, studies are under way in the United States to investigate the use of nepheline syenite in flat glass manufacturing. Such a development, if successful, would stimulate the consumption of nepheline syenite.

The major consumers of nepheline syenite in Canada are: Consumer Glass - a div. of Consumer Packaging Inc., Fiberglas Canada Inc., American Standard Inc. and Crane Canada Inc. Important consumers of feldspar are: Crane Canada Inc., Electro Porcelain Co. Ltd., Hamilton Porcelains Limited, J M Asbestos Inc. and Cegelec Industrie Inc.

TRADE

Exports of nepheline syenite have declined considerably from 1980 to 1986. However, exports have increased steadily since the industry was rationalized in 1986, when Indusmin purchased the mining and concentrating operation of International Minerals & Chemical Corporation (IMC) located at Blue Mountain, Ontario. The United States remains our largest market accounting for approximately 90% of our trade.

Market Areas for North American Producers of Feldspar, Nepheline Syenite and Aplite

Market area	Material
Central and eastern Canada and north-central United States	nepheline syenite
Northeast United States	feldspar
East-central United States	aplite
Southeast and south-central United States	feldspar
Southwest United States	feldspar-silica sand, feldspar

PRICES

The unit value of production (shipments) of nepheline syenite was $45.89/t in 1989; this compares with $40.34 in 1988. The unit value of exports to our major market, the United States was $44.12/t (based on nine-month figures) in 1989.

Listed prices for nepheline syenite which had not been increased since 1986, were increased during the year. Glass grades increased 13%; ceramic grades 20%; and filler/extender grades 7.6%.

USES

Nepheline syenite is preferred to feldspar as a source of alumina and alkalis for glass manufacture. Its use results in more rapid melting of the batch at lower temperatures than with feldspar, thus reducing fuel consumption, lengthening the life of furnace refractories and improving the yield and quality of glass. Other industrial uses for nepheline syenite include ceramic glazes, enamels, fiberglass and fillers in paints, papers, plastics and foam rubber.

Feldspar is the name of a group of minerals consisting of aluminum silicates of potassium, sodium and calcium. It is used in glass-making as a source of alumina and alkalis, in ceramic bodies and glazes, in cleaning compounds as a moderate abrasive and as a flux coating on welding rods. High-calcium feldspars, such as labradorite, and feldspar-rich rocks, such as anorthosite, find limited use as building stones and for other decorative purposes. Potash feldspar is an essential ingredient in the manufacture of high-voltage porcelain insulators. Dental spar, which is used in the manufacture of artificial teeth, is a pure white potash.

OUTLOOK

Increased recycling of glass in North America is expected to continue to impinge upon the consumption of nepheline syenite and feldspar.

On the positive side, research continues on the development of glass containers that are strong, lightweight (thinner glass wall) and safer (glass wall covered with plastic foam) which would be competitive with other container materials. The long-term goal is to produce glass containers that would weigh about half their present weight. Although the new product would require less raw materials, the additional demand may more than offset the reduction in unit consumption of raw materials.

Finally, increasing environmental awareness and the disposal problems posed by plastic containers should encourage a greater use of glass containers which are easier to recycle.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, NEPHELINE SYENITE PRODUCTION, EXPORTS AND CONSUMPTION, 1986–89

	1986		1987		1988		1989	
	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)	($000)
Production (shipments)	467 491	18 922	506 415	20 664	539 835	21 775	555 728	25 500
Exports[1]							**(Jan.-Sept.)**	
United States	297 990	14 760	318 743	15 504	428 478	15 126	271 357	11 973
Netherlands	19 036	1 135	21 028	1 547	52 437	3 817	22 602	1 841
Italy	5 672	512	2 791	304	8 773	851	2 204	220
Spain	1 190	125	2 042	212	4 194	489	1 469	183
Japan	1 661	215	1 177	148	1 758	245	417	53
Taiwan	887	122	1 580	186	2 017	393	341	73
Australia	5 316	360	6 017	392	88 478	93	120	25
France	738	134	545	110	1 101	282	115	36
United Kingdom	4 856	269	335	41	164	29	110	23
Belgium-Luxembourg	127	18	86	13	72	14	108	25
Other countries	787	96	1 799	204	1 264	220	433	90
Total	338 260	17 744	356 144	18 662	588 736[4]	21 569	299 276	14 555
Consumption[2]								
Primary glass and containers	58 265	. .	62 731	. .	49 913	. .	. .	. .
Ceramic products	13 750	. .	14 592	. .	19 225	. .	. .	. .
Paints	6 095	. .	6 876	. .	6 968	. .	. .	. .
Others[3]	16 294	. .	15 452	. .	14 902	. .	. .	. .
Total	94 404	. .	99 651	. .	91 008	. .	. .	. .

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] Beginning 1988 Exports and Imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Exports include H.S. class 2529.30.20. [2] Available data, as reported by consumers. [3] Includes glass fibre wool and glass fibre, plastics, structural clay products, pulp and paper and paper products, and other minor uses. [4] After discussion with company officials it is felt that Export trade data may be overstated.

. . Not available.

TABLE 2. TYPICAL RAW BATCH FORMULATION FOR GLASS CONTAINERS AND CERAMICS

Raw Materials	Percent by Weight
Glass Containers:	
Silica sand	62-63
Nepheline syenite	5-6
Soda ash	21-22
Burnt lime	8-9
Baryte	0-1
Gypsum	0-1
Decolorizers	As required
Cullet	As required
Low temperature ceramic vitreous body:	
Nepheline syenite	54
Kaolin	24
Ball clay	16
Flint	6

Source: Ceramic Bulletin, Vol. 65, No. 5, 1986.

TABLE 3. CANADA, NEPHELINE SYENITE PRODUCTION AND EXPORTS, 1975 AND 1980–88

	Production[1]	Exports[2]
	(tonnes)	
1975	468 278	356 629
1980	600 000	448 468
1981	588 000	476 281
1982	550 480	414 788
1983	523 249	398 299
1984	520 640	387 069
1985	467 186	351 032r
1986	467 491	338 260r
1987	506 415	356 144
1988	555 728	588 736

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Producers' shipments. [2] Beginning 1988 Exports and Imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Exports include H.S. class 2529.30.20.

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TABLE 4. CANADA, FELDSPAR CONSUMPTION[1], 1985–88

	1985	1986	1987	1988p
		(tonnes)		
Consumption				
Ceramic products	1 924	2 067	2 293	2 489
Other products[2]	90	181	47	85
Total	2 014	2 248	2 340	2 574

Source: Energy, Mines and Resources Canada.

[1] Available data, as reported by consumers. [2] Includes adhesives, abrasives and other minor uses.

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TABLE 5. CANADA, CONSUMPTION AND VALUE OF IMPORTS OF CRUDE OR GROUND FELDSPAR, 1975 AND 1980-88

	Imports[1]	Consumption[2]
	($)	(tonnes)
1975	. .	5 630
1980	385 000	4 051
1981	642 000	4 606
1982	251 000	2 790
1983	309 000	2 213
1984	310 000	2 106
1985	308 000	2 014
1986	357 000	2 248
1987	475 000	2 340
1988	371 000	2 574p

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning 1988 Exports and Imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Imports include H.S. class 2529.10. [2] Available data, as reported by consumers.

p Preliminary; . . Not available.

Nickel

1989

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For the second consecutive year, market conditions were exceptionally buoyant. The nickel market was strong in the first half of the year and then weakened in the second half but, on average, the prices were only marginally lower than the record levels of 1988.

Demand in the western world is estimated to have increased slightly to about 660 000 t from 655 000 t in 1988. Demand from the stainless steel sector, which accounts for about 60% of the usage, was particularly strong in the first half of the year.

Producers operated at their effective capacities and, partially due to a lack of major supply disruptions, production was higher in the western world in 1989 by an estimated 10 000 t. As demand softened in the second half, producers started to rebuild inventories which had been depleted to very low levels.

The nickel price on the London Metal Exchange (LME) averaged US$6.04 in 1989, compared to $6.25 in 1988 and $3.06 for the 1980s.

CANADIAN DEVELOPMENTS

Canadian nickel production decreased slightly in 1989 due mainly to lower production by Inco Limited at Thompson, Manitoba and by Falconbridge Limited at Sudbury, Ontario. Inco experienced technical problems due to high arsenic values in the Thompson Open Pit North, and the Falconbridge ore processed was somewhat lower in grade than the previous year. This reduction was partially offset by production from the small Redstone mine, which opened near Timmins, Ontario and increased production from the Namew Lake mine near Flin Flon, Manitoba. (Additional information on nickel mines is listed in the table on Nonferrous and Precious Metal Mine Production which follows the last commodity chapter of this Yearbook.)

A major corporate development was the $2.2 billion takeover of Falconbridge by Noranda Inc. and Trelleborg AB of Sweden. Falconbridge is now owned on a 50:50 basis by Noranda and Trelleborg.

Falconbridge proceeded with a $33 million underground development program at its Lindsley property, near Sudbury. A shaft will be sunk to 1390 m followed by a drifting and drilling program on the 1310 m level. Several potentially mineable ore zones have been identified. The program will be completed in 1991.

Falconbridge also announced plans to develop, at a cost of $280 million, the Craig mine at Sudbury. The mine will produce more than 20 000 t/y nickel when it is in full production which is scheduled for late 1993. The mine will be a replacement for other depleting mines and no overall increase in production is planned.

Inco announced plans to develop the McCreedy East mine near Sudbury, at a cost of $179 million. The deposit is expected to commence in 1993, with full production being achieved in 1996. Peak production is expected to be about 18 000 t/y nickel and 9000 t/y copper. This mine will be the first major new mine to be developed by Inco at Sudbury in more than 20 years. The deposit is the largest known undeveloped, high-grade nickel-copper deposit in the Sudbury region. The mine, which will utilize the latest bulk-mining techniques and mining technology, is expected to be Inco's most productive mine at Sudbury.

Inco re-opened its Shebandowan mine west of Thunder Bay, Ontario, which had been closed in 1986 due to low nickel prices. The concentrate is being shipped to Sudbury for smelting. Outlined reserves of 3 Mt grading 2.2% nickel and 1% copper are sufficient for four years of production.

At Thompson, Manitoba, Inco proceeded with its $100 million development of the Thompson Open Pit South mine and reactivation of the Birchtree mine. Ore from these mines will replace that from the Thompson Open Pit North which will be depleted in 1990.

Sherritt Gordon Limited produced about 21 000 t of nickel in briquettes and powders at its Fort Saskatchewan, Alberta refinery, compared to 24 000 t in 1988. The major factor for lower production was technical difficulties encountered in processing some off-specification feed from Inco.

The 10-year nickel supply contract between Sherritt and Inco expired at the end of 1989. During the 1980s, Inco had been the major source of feed for Sherritt, but it has been able to obtain a supply from some other sources to replace part of the Inco material and other potential sources of supply are being pursued.

Mining difficulties continued to be experienced at the Namew Lake mine, owned 60% by Hudson Bay Mining and Smelting Co., Limited (HBMS) and 40% by Outokumpu Mines Ltd. Excess water in the underground workings has adversely affected mining since it opened in 1988, but some other problems have been encountered, including a higher-than-expected waste-to-ore ratio. Nameplate capacity is 9200 t/y nickel and 3500 t/y copper in concentrate. Production in 1990 could be about 75% of this but, nevertheless, about double the rate in 1989. Reserves, when the mine opened, had been reported at 2.6 Mt grading 2.44% nickel and 0.9% copper. Sherritt processes HBMS's 60% share of the feed at Fort Saskatchewan and Inco processes Outokumpu's share at Thompson.

The small high-grade Redstone nickel mine near Timmins, Ontario was brought into production in mid-year. Capacity of the operation is 2300 t/y nickel. Diluted probable ore reserves were estimated at 318 000 t grading 2.9% nickel with significant potential for further reserves. The mine is 51% owned by Timmins Nickel Inc., which is also the operator, and 49% by BHP-Utah Mines Ltd. The ore is being custom milled nearby by Giant Yellowknife Mines Limited, and Sherritt, under a 10-year contract, refines the concentrate. Late in the year, Timmins was re-examining the nearby Langmuir mine which closed in 1977. In January 1990, Timmins announced that production would be reduced to an annual rate of 680 t, due to the weakened markets.

With nickel prices at near record levels, there was interest in the nickel deposit of New Quebec Raglan Mines Limited in the Ungava region of northern Quebec, but little additional exploration. Reserves are indicated to be 10.9 Mt grading 3.11% nickel and 0.8% copper with some values in platinum group metals. The company, which became a wholly-owned subsidiary of Falconbridge in 1989, had earlier indicated that sustained prices of US$4/lb., in 1988 dollars, would be needed to bring the deposit into production.

Inco announced that it would have normal summer vacation shut-downs for its domestic operations in 1990. In the Ontario Division, the surface plants at Sudbury will be closed for five weeks starting July 2. The mining operations will close for four weeks starting July 9. The Port Colborne refinery will close for five weeks commencing July 9. The Thompson operations will be closed from July 2-29.

Inco announced that its nickel production would be lower in 1990 than in 1989, due to reduced production at Thompson. The high-grade Thompson Open Pit North will be mined out in 1990 and production cannot be increased fast enough from other mines to make up for the decrease.

WORLD DEVELOPMENTS

Nickel producers operated at their effective capacities to take advantage of high prices. Some capacity which had been closed in the mid-1980s due to weak market conditions was reactivated and some expansion plans were undertaken. A few feasibility studies were launched on possible new facilities. Producers, however, generally believed that medium-to-long-term prices would be lower than the high levels prevailing for most of the year, and they generally demonstrated caution in their plans for expansion or development of new facilities.

In Australia, Western Mining Corporation Limited, at mid-year, re-opened the Lenister mine - formerly Agnew - which had been closed in 1986. Production totalled 3800 t. Capacity of the operation is 9000 t/y.

Outokumpu Oy and Australian Consolidated Minerals Ltd. announced plans to form a 50:50 joint venture to develop the latter's Mount Keith deposit in Western Australia, subject to the outcome of a final feasibility study. The study on the estimated US$330 million project is expected to be completed in the second quarter of 1990. Concentrate would be produced containing 20% nickel which would be shipped to Finland for processing. An existing roaster would be utilized, but a new electric furnace would need to be built at Outokumpu's Kokkola plant. The operation would produce 20 000 t/y nickel in ferronickel.

In Indonesia, the US$80 million expansion project at P.T. International Nickel Indonesia continued on schedule and the complex is expected to have a capacity of 47 600 t/y nickel in matte by the end of 1990. Currently, the plant has a capacity of

36 300 t/y. The Indonesian government is reported to have requested that Inco sell 20% of its interest in P.T. Inco through a share offering on the Jakarta stock exchange. The request conforms to an agreement that Inco signed with the government in 1968. Provided the full offering is completed, Inco's ownership of the company would fall from 78% to 58%.

In Korea, the 12 000 t/y nickel refinery of Korea Nickel Corporation was brought into production in mid-year. The plant converts nickel oxide sinter into utility nickel which is 98% pure nickel. The major customer is Pohang Iron and Steel Co. Ltd. (Posco) which opened up a Korean stainless steel complex in April 1989. The facility is 50% owned by Korea Zinc Co. Ltd., 25% by Posco and 25% by Inco.

A final feasibility study was under preparation by New Zealand Nickel Smelters Ltd. on a possible 10 000 t/y ferronickel smelter on the South Island of New Zealand. The ore would come from New Caledonia. The availability of relatively low-cost power is a major reason for interest in the project.

In the Philippines, the government attempted to sell the mothballed nickel complex of Nonoc Mining & Industrial Corporation, but a buyer which would meet the conditions of the government was not found by year-end. The Philippine Mining and Industrial Corp. had purchased the property in October for US$325 million and initiated some work to rehabilitate the facility, but the work was stopped after certain financial terms of the purchase were not met. The facility has not operated since 1986.

In the United States, Glenbrook Nickel Co. commenced production of ferronickel in August at the Riddle, Oregon plant which had been operated by M.A. Hanna Company until it closed in 1986 due to weak nickel prices. Initial production came from a 5.5 Mt stockpile grading 0.7% nickel. Studies were initiated to examine the feasibility of re-opening the mine and bringing ore in from outside sources, primarily from New Caledonia or Indonesia.

In Finland, production by Outokumpu Oy was below expected levels due to a short strike and an explosion at an oxygen plant. Overall, production was about 2000 t below 1988 levels.

In Sweden, mine production is reported to have commenced at the Arnessjellet mine near Ballangen. Nickel and Olivin AS is scheduled to ship about 45 000 t of concentrate to Outokumpu for processing at its Harjavalta complex in Finland.

Initial production started during the first quarter of 1989 at the 6000 t/y electrolytic nickel cathode plant in Albania. The product is 99.8% nickel, which has been targeted for markets in southern Europe, including Italy and Australia.

Falconbridge examined the possibility of re-opening the Kavadarci ferronickel complex in Yugoslavia. The facility, which has a nameplate capacity of 16 000 t/y nickel in ferronickel, began operation in 1982 and closed in 1984 as a result of a combination of low ore grades, erratic power supplies and weak market conditions. After conducting a feasibility study, Falconbridge decided against re-opening the operation.

In the U.S.S.R., a new company was formed, Noril'sknikel, which includes the vast nickel complex at Noril'sk and the Sevronikel and Pechengnikel plants in the Kola Peninsula. This company controls over 75% of Soviet production.

Cuban production increased to about 48 000 t from 44 000 t as a result of higher production at the Punta Gorda facility. This plant will have a capacity of 30 000 t/y nickel when it is fully operational. In 1989, about 9000 t was produced at Punta Gorda.

The expansion project continued at the Jinchuan nickel complex in western China. The capacity is expected to be doubled to 40 000 t/y nickel metal in 1990. Outokumpu flash furnaces are being installed.

CONSUMPTION AND USES

Nickel consumption was strong in early 1989 in all major market areas, particularly in the capital goods sector which generally accounts for about two thirds of consumption. The manufacturing sector continued to modernize and add capacity, and this increased the demand for various nickel-containing products.

Stainless steel production increased substantially in 1987, 1988 and early 1989 but then started to weaken, particularly in the United States and Europe. Producers took extended summer shutdowns in both these regions. Only in southeast Asia did stainless steel production increase.

Nickel-containing stainless steels continues to be the major growth market for nickel. The demand for nickel from this sector has been increasing faster than for other nickel-containing products. The percentage of total nickel consumption accounted for by this sector is currently estimated to be close to 60%.

The major nickel markets of the United States, Japan and western Europe continue to account for close to 90% of the demand for nickel in the western world, but the newly industrialized countries, particularly in the Pacific Rim region, are increasing their share of the market and this trend is expected to continue in the future.

Resistance to corrosion, high strength over a wide temperature range, pleasing appearance and suitability as an alloying agent are characteristics of nickel which make it useful in a wide range of applications. After stainless steels, the major uses are nickel-based alloys, electroplating, alloy steels, foundry products and copper-based alloys. Nickel is extensively used as an alloying agent and is a component in some 3000 different alloys which are used in more than 250 000 end-use applications.

Nickel is used in chemical and food processing, nuclear power plants, aerospace equipment, motor vehicles, oil and gas pipelines, electrical equipment, machinery, batteries, catalysts and many other applications.

Nickel-containing stainless steel tanks are used for road, rail and sea transport of various liquids including dairy products, petrochemicals and toxic chemicals. These stainless steels are used for their resistance to corrosion, strength and ease of cleaning. The ability to handle a wide variety of liquids adds to their capability or backhaul loads.

In recent years, some Japanese and European auto manufacturers have been using a zinc-nickel coated steel for various body panels and some structural parts. The coating is much more corrosion resistant than ordinary galvanized steel. Bethlehem Steel Corporation acquired the licence from Nippon Kokan KK (NKK) of Japan for the manufacture in the United States of the coating, which contains about 13% nickel with the remainder zinc. Commercial production of the coating started in 1989 from a plant in Walbridge, Ohio. This market for nickel, although relatively small, is expected to grow in the future. As well, the enhanced appearance and low weight of this product makes it potentially attractive for certain other uses.

MARKETS AND PRICES

Nickel markets were tight at the beginning of the year and prices were high. The average price on the LME was US$8.06 in January. Some temporary technical difficulties early in the year at Outokumpu in Finland and P.T. Inco in Indonesia added to the tight market conditions.

Prices started to weaken during the second quarter as more supply became available. Furthermore, demand, particularly from the stainless steel sector, started to show signs of weakening. Prices on the LME averaged US$8.09 in the first quarter, but fell to $6.19 in the second quarter.

It is estimated that there was an overall slight net reduction in inventories during the first half of the year. During the second half, producers started to rebuild inventories.

Continuing the trend started in the second quarter, prices fell during the second half of the year. Prices on the LME averaged US$5.51 in the third quarter and $4.40 in the fourth quarter. On December 29, the price was $3.76.

Ferronickel had been in particularly tight supply in 1988 and, as a result, had been receiving a premium to refined nickel prices. During 1989, however, as demand from the stainless steel industry declined and there were no major supply disruptions such as those which occurred in 1988, ferronickel prices fell substantially. At year-end, ferronickel prices were about 7-8% lower than refined nickel.

INTERNATIONAL NICKEL STUDY GROUP

After several years of discussions, it appears that the International Nickel Study Group (INSG) is close to being inaugurated. The study group will have two main functions: to publish statistical information, and to provide a forum for discussion of issues of concern to governments and industry. Both producing and consuming countries will be members.

The INSG has been closely modelled after the International Lead and Zinc Study Group (ILZSG) which was established in 1959 and is highly regarded by governments and industry. Thirty-two countries are members of the ILZSG and together they account for about 90% of world trade in lead and zinc.

By the end of 1989, 10 countries had committed themselves to membership in the INSG by formally notifying the United Nations. They are: Australia, Canada, Cuba, Finland, France, the

Federal Republic of Germany, Greece, the Netherlands, Norway and Sweden. Together they account for close to 50% of world trade in nickel. The U.S.S.R. is strongly supportive of the INSG and has indicated that it will join at the inaugural meeting.

Some other countries at year-end 1989 were close to joining the study group. The inaugural meeting will be held after additional countries join, and it is expected that this will take place in 1990. All countries which have expressed an interest in the study group will be invited. The headquarters of the INSG is expected to be in the Hague, Netherlands.

HEALTH AND ENVIRONMENT

Under a 1985 Ontario government regulation, Inco and Falconbridge must reduce their emissions of sulphur dioxide to 265 000 t and 100 000 t, respectively, by 1994. In 1985, the limit was 685 000 t for Inco and 154 000 t for Falconbridge.

Inco is proceeding with a $494 million program which should put the company in compliance with the regulation. Of the total, $425 million will be spent on changes to the smelter. The program includes two oxygen flash furnaces, a new sulphuric acid plant, an additional oxygen plant plus some other plant modifications. The new furnaces which Inco has developed will utilize pure oxygen as the fuel and will replace the existing two reverberatory furnaces.

The remaining $69 million will be spent at Sudbury on a mill modernization and rationalization program which is scheduled for completion in early 1991. The Clarabelle mill is being expanded to handle all of the Sudbury ores. A bulk nickel-copper concentrate will be produced which will facilitate increased rejection of pyrrhotite. A semi-autogenous grinding circuit and large flotation cells will be installed. The Frood-Stobie mill will be closed and the Copper Cliff mill will be used only for concentrate dewatering and storage. As well as contributing to cleaning up the environment, the operating efficiency of the plant will also be substantially increased.

Falconbridge is spending $38 million on research, development and capital projects related to increasing pyrrhotite rejection and greater roasting to be able to conform to the regulation. While actual emissions of sulphur dioxide in 1989 were below the required 1994 level, the company was producing below capacity. The company is conducting research on methods to reduce emissions to 75 000 t/y, at capacity production, by 1998. Increased pyrrhotite rejection is the focus of the research.

An issue of increasing concern to the nickel industry is the institution by various countries of stiffer regulations on exposure to nickel, some of which may be unduly restrictive or overly broad in scope. Unnecessary expenses can result for nickel producers and consumers and, as well, certain markets can be adversely affected.

In an effort to increase the scientific knowledge available concerning the health risks associated with exposure to nickel and nickel compounds, an epidemiological study was sponsored by the United States Environmental Protection Agency, the European Commission, the federal departments of National Health and Welfare and Energy, Mines and Resources, the Ontario Ministry of Labour and the Nickel Producers Environmental Research Association. The study, chaired by Sir Richard Doll and completed in 1989, concluded that exposure to high concentrations of certain nickel compounds can result in increased lung and nasal cancers in humans. The study showed that there is no evidence that nickel metal is a carcinogen. The conclusions of the study were used extensively by a working group of the International Agency for Research on Cancer (IARC) which met in June. IARC placed nickel compounds, as a group, in the list of known human carcinogens.

OUTLOOK

In 1990, it is expected that nickel demand will be slightly lower than in 1989 due largely to reduced demand from the stainless steel sector. Stainless steel producers have an excess of inventories that they will reduce before resuming higher production levels. The expected slow-down in many OECD countries will also tend to reduce demand for nickel products.

Producers are expected to continue to operate at their effective capacities and some additional production is expected to be available from producers which are expanding production. Barring any important supply disruptions, there is expected to be further rebuilding of producer inventories in 1990.

The increase in inventories will exert downward pressure on prices and the average price for the year is expected to be substantially less than the US$6.04 on the LME in 1988. An average price within the range of US$3-$4 is possible. If inventories accumulate faster than currently expected, then prices could go below $3 at which time there would be some re-evaluation of production targets by some producers.

In the medium to longer term, it is felt that a price between $3.70 and $4.70, in constant dollars, would be a sustainable price. A price much above this level would result in substantial new capacity and possible substitution, and a price below this level would not assure adequate new supply.

Consumption is expected to grow at an annual rate of about 1.7% to the year 2000. While some more mature markets, like the United States and Japan, are expected to experience somewhat lower growth rates, this will be offset by higher rates in relatively small but emerging markets such as China, Brazil and South Korea.

In Canada, nickel production is expected to increase marginally over the next several years. Canada will remain a highly cost-competitive producer, particularly given the effects of the cost reduction programs which have been put in place in the past few years. An increasing amount of ore will be mined by low-cost bulk mining methods and this will be a significant factor in lowering costs, given that mining accounts for about 50% of operating costs. A major constraint on production, particularly at Inco in Sudbury, will be the limit on permissible sulphur dioxide emissions from the smelter.

The most important potential new development in Canada over the next decade could be the New Quebec Raglan Mines Limited property in northern Quebec. Although the remote location makes it expensive to develop and operate, the high-grade deposits which could be mined by open-pit methods make it an attractive possibility.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
2604.00	Nickel ores and concentrates	Free	Free	Free	Free	Free	Free
7501.10	- Nickel mattes	Free	Free	Free	Free	Free	Free
7501.20	- Nickel oxide sinters and other intermediate products of nickel metallurgy	Free	Free	Free	Free	Free	Free - 81 yen kg[2]
75.02	Unwrought nickel						
7502.10	- Nickel not alloyed	Free	Free	Free	Free	Free	81 yen kg
7502.20	- Nickel alloys	Free	Free	Free	Free	Free	Free - 9%[3]
7503.00	Nickel waste and scrap	Free	Free	Free	Free	Free	Free
7504.00	Nickel powders and flakes						
7504.00.10	--- Powders containing by weight 60% or more nickel	Free	Free	Free	Free	0.5%	Free
7504.00.20	--- Powders containing by weight less than 60% of nickel; flakes	10.2%	6.5%	6.1%	Free	0.5%	65 yen kg - 6%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Customs Tariff Schedules of Japan, 1989.

[1] GATT rate is shown; lower tariff rates may apply circumstantially. [2] Free except for nickel oxide sinters containing by weight not less than 88% nickel which is 81 yen kg, and nickel oxide containing by weight not more than 1.5% copper which is 7.2%. [3] Tariff rate of 9% applies to nickel alloys other than those containing by weight less than 50% of nickel and not less than 10% of cobalt.

TABLE 1. CANADA, NICKEL PRODUCTION AND TRADE, 1988 AND 1989

Item No.		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production[1]					
All forms					
Ontario		128 588	1 742 507	131 567	2 029 897
Manitoba		70 186	1 047 910	64 566	1 050 010
Total		198 744	2 790 417	196 133	3 079 907
Exports[2]				**(Jan.-Sept.)**	
2604.00.00	Nickel ore and concentrates, nickel content				
	Japan	–	–	2	37
	South Korea	. . .	3	2	30
	India	–	–	1	17
	Chile	–	–	1	19
	Norway	7 530	44 686	–	–
	United States	49	693	–	–
	West Germany	2	37	–	–
	Total	7 581	45 421	6	104
7501.10	Nickel mattes				
	Norway	25 793	249 780	25 444	327 638
	United Kingdom	31 675	224 316	18 748	130 211
	United States	80	526	122	2 138
	Switzerland	–	–	6	117
	Other countries	155	1 476	–	–
	Total	57 703	476 102	44 320	460 106
7502.20	Nickel, unwrought, alloyed				
	United States	1 926	14 270	925	6 743
	Belgium	568	3 922	452	3 014
	Other countries	425	2 698	218	1 312
	Total	2 919	20 896	1 595	11 077
7503.00	Nickel waste and scrap				
	United States	4 984	39 980	4 055	50 558
	United Kingdom	431	1 091	732	3 495
	Netherlands	474	3 348	278	1 358
	Austria	–	–	193	30
	Japan	364	1 010	105	290
	Other countries	676	2 869	249	953
	Total	6 929	48 211	5 613	56 687
7504.00	Nickel powders and flakes				
	United States	7 293	70 697	5 474	55 027
	Japan	1 492	13 578	1 151	9 931
	Netherlands	448	6 513	143	2 589
	People's Republic of China	143	1 332	101	815
	Other countries	756	6 073	344	3 847
	Total	10 132	98 201	7 213	72 218

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
7505.12	Bars, rods and profiles of nickel alloy				
	United States	21	184	114	1 594
	Netherlands	16	456	–	–
	Indonesia	10	13	–	–
	Other countries	9	164	–	–
	Total	56	833	114	1 594
7508.00	Articles of nickel, n.e.s.				
	United States	. .	3 863	. .	6 392
	South Africa	–	–	–	5 293
	Netherlands	. .	5 302	. .	2 190
	Other countries	. .	553	. .	791
	Total	. .	9 727	. .	14 676
Imports[3]					
2604.00.00.20	Nickel ores and concentrates, nickel content				
	Finland	–	–	1 097	7 392
	United States	1 202	4 698	. . .	1
	Total	1 202	4 698	1 097	7 393
7501.00	Nickel mattes, nickel oxide sinters and other intermediate products of nickel metallurgy				
	United Kingdom	810	1 281	496	2 450
	United States	4	1	392	1 182
	Australia	3 029	23 850	351	2 448
	Poland	–	–	294	1 080
	Other countries	363	1 404	146	682
	Total	4 207	26 538	1 679	7 844
7502.10	Nickel unwrought, not alloyed				
	Norway	827	6 666	1 381	23 232
	U.S.S.R.	–	–	1 143	19 255
	Other countries	582	4 149	187	3 154
	Total	1 409	10 818	2 711	45 645
7502.20	Nickel unwrought, alloyed				
	Norway	–	–	254	4 337
	United States	273	1 671	165	1 504
	West Germany	–	–	. . .	1
	Total	273	1 671	419	5 843

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
7503.00	Nickel waste and scrap				
	United States	11 797	29 871	9 042	29 153
	United Kingdom	867	1 732	266	767
	Norway	353	698	169	1 326
	Belgium	22	40	166	232
	Australia	758	2 782	154	686
	Other countries	747	1 842	336	697
	Total	14 544	36 971	10 133	32 866
7504.00	Nickel powder and flakes				
	United States	116	1 474	58	978
	Other countries	61	558	13	269
	Total	177	2 034	71	1 249
7505.12	Bars, rods and profiles of nickel alloy				
	United States	522	10 478	330	6 426
	Other countries	23	387	19	433
	Total	545	10 869	349	6 861
7508.00.10.00	Nickel anodes for electroplating				
	United States	149	1 252	25	174
	Other countries	40	352	3	21
	Total	189	1 606	28	196

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Refined nickel and nickel in oxides and salts produced, plus recoverable nickel in matte and concentrates exported. [2] Item Nos. 7501.20 (nickel oxide sinters and other intermediate products of nickel metallurgy) and 7502.10 (nickel unwrought, not alloyed) suppressed due to confidentiality.

[3] Imports from "other countries" may include re-imports from Canada.

p Preliminary; – Nil; . . Not available or not applicable; n.e.s. Not elsewhere specified; . . . Too small to be expressed.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, NICKEL PRODUCTION AND CONSUMPTION 1970, 1975 AND 1980–89

	Production[1]	Consumption[2]
1970	277 490	10 699
1975	242 180	11 308
1980	184 802	9 676
1981	160 247	8 603
1982	88 581	6 723
1983	125 022	5 010
1984	173 725	7 502
1985	169 971	7 206
1986	163 640	8 865
1987	189 086	9 738
1988	198 744	9 812p
1989p	196 133	. .

Source: Energy, Mines and Resources Canada.

[1] Refined nickel and nickel in oxide and salts produced, plus recoverable nickel in matte and concentrates exported. [2] Consumption of metallic nickel, all forms (refined metal, and in ferronickel oxides and salts) as reported by consumers on the EMR survey "Consumption of Nickel."

p Preliminary; . . Not available.

TABLE 3. CANADIAN PROCESSING CAPACITY, 1989

	Inco Limited		Falconbridge Limited	Sherritt Gordon Limited
	Sudbury	Thompson	Sudbury	Fort Saskatchewan
			(t y of contained nickel)	
Smelter	110 000[1]	81 600	45 000	n.a.
Refinery	56 700	49 900	n.a.	25 000

[1] Capacity is constrained to this level by an Ontario government regulation on SO_2 emission limits.

n.a. Not applicable.

TABLE 4. WORLD MINE PRODUCTION OF NICKEL, 1987 AND 1988

	1987	1988
	(tonnes)	
Canada[1]	189 100	198 700
U.S.S.R.[2]	195 000	205 000
Australia	74 600	62 400
New Caledonia	58 300	68 700
Indonesia	57 200	59 800
Cuba	35 900	43 800
South Africa	34 300	34 800
Botswana	16 500	22 500
People's Republic of China	30 400	28 600
Dominican Republic	32 500	29 300
Other	87 800	94 000
Total	811 600	847 600

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
[1] Refined nickel and nickel oxide and salts produced, plus recoverable nickel in matte and concentrates produced. [2] As a result of a 1988 Canadian government industry nickel mission to the U.S.S.R., it is believed that the data from the WBMS significantly understates Soviet production but an alternate number is not put forward at this time.

TABLE 5. WORLD CONSUMPTION OF NICKEL, 1987 AND 1988

	1987	1988
	(tonnes)	
Japan	153 900	161 700
United States	141 000	140 600
U.S.S.R.[1]	135 000	130 000
Federal Republic of Germany	81 100	89 400
France	39 300	39 600
Italy	28 800	28 600
United Kingdom	33 100	33 000
People's Republic of China	24 000	27 500
Sweden	16 800	20 000
India	19 300	15 000
Other	164 700	188 700
Total	837 000	874 100

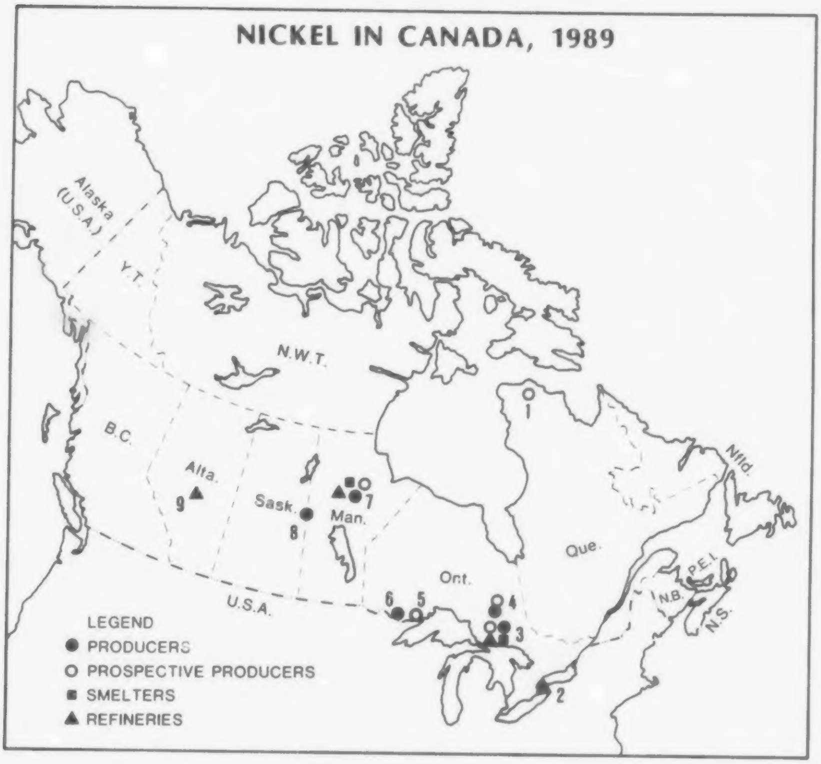
Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.
[1] As a result of a 1988 Canadian government industry nickel mission to the U.S.S.R., it is believed that the data from the WBMS significantly understates Soviet consumption but an alternate number is not put forward at this time.

TABLE 6. AVERAGE ANNUAL NICKEL PRICES, 1980–89

Year	London Metal Exchange - Spot (US$/lb.)
1980	2.96
1981	2.71
1982	2.18
1983	2.12
1984	2.16
1985	2.22
1986	1.76
1987	2.19
1988	6.25
1989	6.04

TABLE 7. AVERAGE MONTHLY NICKEL PRICES, 1988 AND 1989

	1988	1989
	(US$/lb.)	
January	3.67	8.06
February	3.94	8.42
March	7.09	7.80
April	8.21	6.94
May	7.75	6.12
June	7.10	5.56
July	6.63	5.58
August	6.48	5.86
September	5.43	5.10
October	5.27	4.74
November	6.07	4.45
December	7.69	4.00


NICKEL IN CANADA, 1989
Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
N.B.
P.E.I.
N.S.
U.S.A.
1
2
3
4
5
6
7
8
9
LEGEND
● PRODUCERS
○ PROSPECTIVE PRODUCERS
■ SMELTERS
▲ REFINERIES

Producers, prospective producers, smelters and refineries
(numbers refer to locations on map above)

Producers

3. Falconbridge Limited
   (East, Fraser, Lockerby, Onaping, Strathcona)
   Inco Limited
   (Copper Cliff North, Copper Cliff South, Crean Hill, Creighton, Frood, Levack, Little Stobie, McCreedy West, Stobie and Whistle)
4. Timmins Nickel Inc.
   (Redstone)
6. Inco Limited
   (Shebandowan mine)
7. Inco Limited
   (Thompson, Birchtree and Thompson Open Pit North)
8. Hudson Bay Mining and Smelting Co., Limited (Namew Lake)

Prospective Producers

1. New Quebec Raglan Mines Limited
3. Falconbridge Limited (Craig, Lindsay)
   Inco Limited (Clarabelle, Coleman, Garson, Crean Hill, Murray, Totten)
4. Teck Corporation
   (Moncalm Township)
5. Great Lakes Nickel Limited
   (Pardee Township)
7. Inco Limited
   (Thompson Open Pit South, Soab North, Soab South and Pipe No. 1)

Smelters

3. Falconbridge Limited (Falconbridge)
   Inco Limited (Sudbury)
7. Inco Limited (Thompson)

Refineries

2. Inco Limited (Port Colborne)
3. Inco Limited (Sudbury)
7. Inco Limited (Thompson)
9. Sherritt Gordon Limited
   (Fort Saskatchewan)

Peat

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Peat is an intermediate matter resulting from the biochemical decomposition of plants. In its raw material form, it is ligneous, fibrous and elastic. It has a pH of 2.8-4.0 and an ash content of 0.5-2.5%. Peat is composed of organic residues accumulated from the anaerobic decomposition of plant matters, and is found in peat bogs, swamps and marshes. Its main properties are its high water-retaining capacity, low density, high resistance to decomposition, low heat conductivity and high porosity. It can hold up to twenty times its weight in liquids and gas. Peat is divided into two principal types according to its botanical composition and degree of decomposition. Horticultural peat is relatively undecomposed, with a von Post value of H1-H5. It has a high fibre content, is light yellowish brown in colour and contains few colloids. Fuel peat is highly decomposed, with a von Post value of H6-H10. It is blackish in colour and contains colloid residues. Peat moss is the terminology given to commercial peat used in horticulture.

The total area of peatlands in Canada is estimated at 111 328 000 hectares (ha), covering close to 12% of the country's land surface. Approximately 60% of all Canadian peatlands are perennially frozen. Indicated peat resources total approximately 3 004 996 Mm^3, equivalent to 338 000 Mt of dry peat. Measured resources are estimated at 1092 Mt.

Peat production in Canada is limited to a short harvesting season - from May to September - due to weather conditions which hinder drainage and drying of the peat.

Canada mainly produces sphagnum peat, which is used in horticulture and agriculture. It is harvested primarily in eastern and southeastern Quebec, in northeastern and eastern New Brunswick, and in western Canada near Edmonton (Alberta), Carrot River (Saskatchewan), Giroux and Elma (Manitoba). Sphagnum moss production also occurs in Nova Scotia, Prince Edward Island, Newfoundland and Ontario.

PRODUCTION AND TRADE IN CANADA

In 1989, Canadian peat production was estimated, at 676 800 t, a small 3% decline from last year. Production in eastern Canada remained stable as the harvesting season started late in June and ended in October. The late start was compensated by a longer period, extended one month over a normal season. Weather conditions in May and June were sluggish while July was exceptionally sunny. Intermittent showers occurred in August and favourable conditions prevailed afterward up to the third week of October. In western Canada, the season started late in April and lasted six months, experiencing wet summer conditions in June and July. The western Canadian peat production was reduced by close to 18%, while some increases were registered in eastern Canada, namely in New Brunswick, Nova Scotia and Quebec. Eastern Canada accounted for 79% of total Canadian production of sphagnum peat.

The 1989 shipments declined 6% to 694 853 t, valued at $77 million. Quebec accounted for 48%, followed by New Brunswick (31%), Manitoba and Alberta. Major declines occurred in Alberta (-15%), New Brunswick (-10%) and Quebec (-4%), while significant sales were reported in Saskatchewan. Sales from Nova Scotia and Manitoba remained stable. The average unit value continued to decrease for the third consecutive year, reaching $111.14/t, a small 1.2% drop over 1988.

Shipments during the first half of 1989 remained stable compared to the same period of the previous year. Lower inventory in early 1989 limited the extensive utilization of discounting and dating in the marketplace. The late starting season provided the incentive for obtaining an overall 5-10% increase in prices by mid-year. These price hikes were strongly needed by the industry, which showed very low profitability, if any, during the last 18 months. Faced with increasing costs (bags, freight, etc.), producers were furthermore affected by the continuous rise of the Canadian dollar during the last two years, since sales are usually quoted in U.S. dollars. In late spring, most sales were sourced from inventories which bottomed out in

June at half of the level prevailing in June 1988. However, the extended period of harvesting in 1989 permitted the refurnishment of bale stocks to an even higher level compared to that of last year. As sales were slow in the fall of 1989, market pressures were exerted on suppliers to deliver peat products at a more competitive price, especially to established producers.

Most Canadian peat production was used in horticulture, nurseries and landscaping and by mushroom growers. Domestic consumption of peat was estimated at 12% of total shipments, the remainder being exported. Shipments comprised peat in bulk, bales and value-added products such as pots and mixes.

In 1988, exports of peat increased 44% to 689 977 t, valued at $103 million. Canada exported to about 40 countries of which the United States contributed for 84%, followed by Japan (8%) and Saudi Arabia (2%). In the first nine months of 1989, Canadian exports amounted to 508 739 t, a 13% decrease over the same period in 1988. The unit value of exports rose 12% to $158.61/t, mostly due to a sharp variation in the U.S.-Canadian currency exchange rate. Exports were delivered to 33 countries dominated by the United States (90%) and Japan (8%). Shipments to the Netherlands doubled while exports to Australia, Puerto Rico and Saudi Arabia remained strong.

DEVELOPMENTS IN CANADA

In western Canada, Premier CDN Enterprises Ltd. of Rivière-du-Loup, Quebec, started a new peat operation in Alberta; Premier Northal Ltd. is located in the Athabasca area and produces peat bales for the North American market. Hood Mfg. Enterprises Ltd. and Lakeland Peat Moss Ltd. completed a merger under the new name of Lakeland Hood Corporation and continued to produce peat bales at Evansburg and Mallaig. Trade-tech Industries Ltd. entered into its second year of production and produced peat bales for export to the United States. In Manitoba, Premier West Peat Moss Ltd. suffered from a six-month delay at its operation near Giroux after a fire occurred in the storage facilities during January; normal bagging operations resumed in June.

In central Canada, Lindeidt Peat Inc. shut down its operations near Bingo Lake in Marathon Township, Ontario, after its commissioning last year. In Quebec, Fafard & Brothers Ltd. started two new operations in the Lac-St-Jean area. New surfaces and a new modern bagging plant were put on-stream in St-Ludger-de-Milot while surface work at Ste-Marguerite was completed for supplying Produits Desbiens Inc. Johnson & Johnson Inc. carried out trial runs at the St. Raymond plant; production of peat-based absorbent products is expected by late 1990; the $17 million project will be supplied by Fafard and will provide employment for up to 40 workers. Several peat operations changed ownership during the year: Tourbières Norbec Inc., Tourbière Procar Inc. and Tourbière St-Fabien. Tourbière Procar in Ste-Eugene was shut down during 1989 following a fire in the bagging plant.

In Atlantic Canada, several producers that acquired exploration and exploitation permits in 1988 had to file an application with the Department of the Environment in New Brunswick. Premier CDN Enterprises Ltd. of Rivière-du-Loup delayed the development of a peat bog in the Bull Pasture area due to environment requirements. A similar situation occurred at Burnt Church Peat Moss Co. Ltd., acquired by Fafard Peat Moss Company Ltd. last year. Jiffy Products (N.B.) Ltd. encountered shipping problems in September when a fire broke out in its finished product storage facility. Delays in production lasted three weeks. Lameque Peat Moss Ltd. restructured its operations under a new name, Lameque Quality Group Ltd., which owns four operations in New Brunswick. One of its companies, Canadian Supreme Products Ltd. of Rivière-du-Portage, was shut down in 1989, reportedly for one year. Miramichi Peat Moss Ltd. put on-stream a new peat bog and bagging facility. The operation is to produce coarse (or granular) peat products for sales in the offshore markets. Equipment modifications were carried out during the summer as efficiency was reported to be low.

During 1989, the new Canadian Sphagnum Peat Moss Association initiated an extensive information and education campaign aimed at U.S. consumers. The promotion includes the establishment of a new hotline in the United States (1-800-776-PEAT) and a new maple leaf logo identifying sphagnum moss bales. "Healthier growth, Naturally" and "Peat is for Every Planting Need, Buy a Bale Today" are the new inspiring promotional pitches to capture the interest of potential buyers in the United States. The objective of the campaign is to enhance acceptance and demand for Canadian peat products in the American retail market by increasing the awareness of consumers of the multiple benefits of using sphagnum moss.

INTERNATIONAL DEVELOPMENTS

World Production and Trade

In 1988, world peat production was estimated at 189 Mt, of which about 169 Mt were for horticulture usage. The U.S.S.R. was the world's largest producer of agriculture peat with a 97% share, followed by West Germany (1.1%), the United States (0.4%) and Canada (0.4%). Fuel peat production accounted for 10.5% of world total output and was mainly produced in the U.S.S.R. (55%), Ireland (27%) and Finland (16%). Only six countries contributed to 98% of world trade, of which West Germany had a 50% share, followed by Canada with 21%. Major trading regions comprised Western Europe and North America. World trade of peat accounted for less than 2% of world production. Imports were concentrated in seven countries with 80% of total imports. The Netherlands was the largest importer with a 23% share, followed by the United States (18%), France (14.1%) and the United Kingdom (9%). World resources of peat were estimated at 1.9 trillion tonnes with the U.S.S.R. accounting for 40% and Canada for 27%.

United States

In 1989, the United States ranked as the third largest world producer of agricultural peat. Peat production declined 3% to 790 000 t, valued at US$18-19 million. Close to 90 operations were active in 20 states, mainly Florida, Michigan, Illinois and New Jersey. Reed-sedge peat accounted for 60% of total production, followed by humus peat (25%). Sphagnum peat moss was produced in 15 operations in 9 states, and accounted for 10% of total production. Apparent consumption of all types of peat remained flat at 1.3 Mt while sphagnum peat shipments increased during 1989 with the commissioning of new operations in Minnesota.

The U.S. apparent consumption of sphagnum peat was estimated at 620 000 t in 1989, compared to 480 000 t in 1987. Domestic shipments contributed for 13% to this expanding market, while the balance was almost totally met by imports from Canada.

Domestic prices on an f.o.b. basis decreased 2% to US$21.00/t, a five-year record low. Imports rose 1.7% to 544 000 t, of which 99% was from Canada. Import prices were quoted at US$126 per short ton on an average custom value basis, compared to $126.46/t in 1988. The net import reliance over apparent consumption continued to rise for a third consecutive year and reached 41%.

Japan

Japan remained the second largest importer of Canadian peat moss, accounting for 16% of Canada's exports in 1989. During 1988, Japan imported 52 591 t, a record high since the beginning of the 1980s. Compared to 1981, sales of peat to Japan increased threefold. Canada continued to be the predominant supplier of peat with a 95% share of the Japanese market. On a nine-month basis in 1989, Canada exported close to 39 000 t to Japan; the unit value of exports rose 7% to $223.36/t, ending a two-year decline. In April 1989, local buyers established a new Japanese Peat Moss Importers Association. During 1989, price quotations on a c.i.f. basis ranged between US$353-381/t, averaging US$360/t.

The major end-use for sphagnum peat moss is industrial landscaping accounting for two thirds of total consumption and including hydro-seeding, tree planting, etc; the remainder is for use in agriculture and horticultural applications such as greenhouse food production, rice nurseries, flowers and general gardening usage.

The peat market is expected to remain strong despite a declining growth rate from its high level that has prevailed since 1985. Japan remained a very demanding market where peat quality and reliability of supplies were very important. Currently, there are some indications for less stringent specifications being taken into consideration as a result of intensifying competition and increasing prices. For the next few years, demand for specialized peat products such as coarse peat is forecast to expand.

Ireland

Ireland was the second largest world producer with 3% of total production, and the fourth largest exporter. In 1988-89, peat production amounted to 8.4 Mt of which 95% was for fuel usage. Bord na Móna, a state-owned corporation, contributed 84% of total Irish output. Ireland produced milled peat, sod peat and milled moss peat. Milled peat is peat in powder or in crumb form and is used for the production of peat briquettes and by local power stations. Sod peat or machine turf peat is extruded peat used for general and domestic fuel usage. In 1988-89, milled peat production rose 37% to 6.4 Mt over 1988 while moss peat output increased 34% to 350 000 t; those increases were mostly due to favourable weather conditions and improving recovery rate. The peat harvesting period lasted from May to August. The peat industry employs close to 3000 persons.

Half of Bord na Móna production is sold on the open market while the rest, mainly milled peat, is shipped to The Electricity Supply Board (E.S.B.). In 1989, close to 410 000 t of briquettes was manufactured from milled peat. In Ireland, fuel peat accounted for about 15% of its total primary energy output. Close to 90% of horticultural peat production was exported to more than 27 countries. The major destination for exports was the United Kingdom with an 80% share; other markets were France, the Netherlands, the Middle East, Africa and Central America.

Finland

Finland was the third largest peat producer in the world and the fifth largest exporter. In 1988, close to 3.5 Mt of peat was produced of which milled peat accounted for 81%, sod peat for 10% and horticultural peat for 9%. Two thirds of the total milled peat output was carried out with the Haku method, the remainder being harvested with mechanical collection wagons. Vapo Oy is a state-owned corporation which accounted for 85% of total Finnish peat production. Close to 30 plants were active in Finland.

The harvesting season is usually relatively short with 30-40 effective production days. Peat production lasts from May to October, but peaks in June and July. Close to 46 000 hectares were in production in 1988, representing less than one percent of the Finnish bog surface.

Over the last 10 years, fuel peat production has tripled in conjunction with increasing demand for energy in the domestic market. Milled and sod peat products are used as fuel, accounting for 4% of the total energy consumption in Finland. Half of this volume is consumed by power plants while the second half is for industry usage. By 1994, fuel peat sales are projected to increase by 40% due to the commissioning of several new fuel peat power plants.

Horticultural peat production doubled during the past decade with record years in 1980 and 1982. The market for horticultural peat is evenly split between exports and domestic sales. The retail market is dominated by home gardeners who use peat for landscaping and foliage plants nurturing. The main export destinations are England, the Netherlands and France, while smaller shipments are for Denmark and Sweden.

USES

Sphagnum peat is extracted from peatlands and dried. After the fibres are removed, it is pressed into bales. It is marketed in three forms. In its natural state, peat is sold in bulk form within a 100 km radius of production centres. When packaged in bags or bales, peat is compressed using a ratio of 2:1. The most common bale sizes are 170 dm^3 (6 ft^3), 113 dm^3 (4 ft^3), and 56 dm^3 (2 ft^3). Peat is mixed with fertilizers and other products, such as vermiculite and perlite, to form a substrate, and with limestone, soil and fertilizers to form potting soil.

Because of the range of its physical and chemical properties, peat has many uses. It is used in its natural state in agriculture and horticulture to loosen up clay soils, to maintain moisture in sandy soils and to add organic matter and fertilizers to depleted soils. Peat is also used as a horse, cattle and poultry litter to absorb liquids and odours. Peat is used in the production of artificial mixtures such as potting soil, seed carriers, peat-perlite and peat-vermiculite mixes, fertilizers and composts. It is also used in the production of peat pots for sprouting plants.

Peat has several industrial applications. It can be used in the production of paper towels, chemical products, metallurgical coke and activated carbon (charcoal). Peat is also used to purify industrial and residential effluents. Its cellular structure, absorbing properties and high capacity for ionic exchange constitute adequate qualities for it to be used as a natural filter. Peat can reduce the acidity of drainage from old mines and remove iron oxides from waste and drainage water. Peat acts as an aid for therapy in balneology, gynaecology and rheumatology. Peat moss has been used as an oil spillage absorbent and in medical tampons.

Fuel peat is recognized as an alternate source of energy. This form of biomass is widely used as fuel in several European countries, such as Ireland and Finland, and in the U.S.S.R. The calorific value of dry Canadian peat is approximately 4700-5100 kcal/kg, compared with oil at 9900-10 000 kcal/kg and coal at 4800-5800 kcal/kg. Peat, as a fuel, is fired in furnaces to produce the steam needed to drive turbines generating electricity. Fuel peat can be processed to produce coke, synthetic natural gas and methanol. Fuel peat has a high degree of humification, a high bulk density, a high calorific value, a low ash content and a low percentage of pollutants such as sulphur and mercury.

OUTLOOK

The year 1990 will be a crucial one for the Canadian peat industry; with sufficient stocks and good harvesting in 1989, suppliers are contemplating a favourable market for peat bales and value-added peat products. The peat industry in Canada is under a period of consolidation reflecting on two years of marginal profitability. Several investments are being deferred while awaiting better economic returns. Many producers envision further rationalization in their operations. Some shutdowns, temporary or permanent, are expected in isolated or marginal producing centres. Producers are pursuing plans to increase their productivity and reduce their operation and distribution costs. Current marketing trends comprise direct selling without brokers and closer access to consumers with a new network of distributors and processing units.

In western Canada, producers are consolidating their operations as new plants and recent mergers improved profitability. Downstream integration for the manufacture of value-added peat products will be considered in view of the expanding southwestern U.S. markets. In central Canada, further rationalization is expected in compatibility with investments toward new technologies for producing and commercializing new products. In Atlantic Canada, the rate of opening new peat bogs is expected to decline considerably since producers continue to streamline their operations into more efficient processing centres.

Peat products prices are likely to remain higher than those prevailing during 1987 and 1988 due to the higher cost of production. In 1990, prices may increase between 4-7%, in particular for value-added mixes.

The maturing of the peat industry favours the establishment of several joint ventures for cost-sharing and expertise. Research and development will be carried out in production and commercialization of innovative peat products for use in several new and untapped industrial markets such as packaging, environmental controls, filtration and absorbents.

The major markets for Canadian peat will continue to be the United States and Japan. The strong position of the U.S.S.R. in the European market excludes any major breakthrough for Canadian peat; however, Oceania, Asia and the Middle East are still considered as potentially growing markets. In 1989, the initiative of Canadian producers to form a national peat association for promoting the use of sphagnum moss in North America is a promising marketing plan. With an estimated 65 million gardeners in the United States, the prospect for increasing sales in the retail sector are very good.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2703.00	Peat (including peat litter) whether or not agglomerated	10.2%	6.5%	6.1%	Free
6815.20	Articles of peat	6.8%	4.5%	5.4%	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. PRICES[1] IN UNITED STATES, BY TYPE OF PEAT, 1988

Type	Domestic			Imported[2]
	Bulk	Packaged or bales	Average	Total
	(U.S. dollars per short ton)			
Sphagnum moss	21.56	29.29	27.63	126.46
Hypnum moss	20.04	35.76	29.04	n.a.
Reed-Sedge	18.75	24.09	21.91	n.a.
Humus	16.81	20.42	17.37	n.a.
Other	n.a.	4.90	4.90	n.a.

Source: U.S. Bureau of Mines, "Peat," 1988.

[1] Prices are f.o.b. plant. [2] Average customs values.

n.a. Not applicable; f.o.b. Free on board.

TABLE 2. WORLD PRODUCTION OF PEAT, BY COUNTRY, 1983–88

Country	1983	1984	1985	1986	1987[p]	1988[e]
				(000 tonnes)		
Agricultural use[1]						
U.S.S.R.[e][r]	160 000	158 800	158 800	163 300	163 300	163 300
West Germany	1 870	1 430	1 520	2 020	2 010	2 000
United States	640	715	755	830	870	820
Canada	530	500	645	740	660	735
Netherlands[e]	400	445	455	400	405	400
Ireland[r]	295	295	320	320	335	355
Finland	275	225	340	345	345	345
France[e]	110	225	200	220	210	200
Poland[e]	200	200	200	200	250	200
Hungary[e]	70	70	70	70	70	70
Sweden	60	60	40	60	60	60
Spain	40	55	55	50	50	50
Denmark	30	30	40	50	50	50
Norway	30	30	30	30	30	30
Israel	20	20	20	20	20	20
Other	1 225	1 010	925	430	490	340
Total	165 795	163 610	163 770	169 085	169 150	168 975
Fuel use						
U.S.S.R.[e]	25 670	17 565	15 925	19 565	11 465	10 900
Ireland	6 650	7 775	2 680	4 725	5 000	5 460
Finland	3 355	2 720	3 150	3 175	3 185	3 185
West Germany	260	275	285	245	240	200
Other	195	215	300	205	260	220
Total	36 130	28 550	22 340	27 925	20 150	19 965
World total	201 925	192 160	186 110	197 010	189 300	189 940

Sources: U.S. Bureau of Mines, "Peat," 1988; Energy, Mines and Resources Canada.

[1] Agricultural use figures have been highly revised for U.S.S.R. and for Ireland.

[p] Preliminary; [r] Revised; [e] Estimated.

TABLE 3. CANADA, PEAT SHIPMENTS BY PROVINCE, 1985–89p

Province	1985[1]		1986		1987r		1988		1989p	
	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value	Quantity	Value
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Newfoundland	1	121	2	149	1	45	2	53	1	44
Prince Edward Island	x	x	x	x	x	x	x	x	x	x
Nova Scotia	9	1 600	x	x	x	x	x	x	x	x
New Brunswick	175	14 700	228	21 351	211	20 405	241	25 428	217	21 630
Quebec	294	21 868	334	30 059	274	25 731	317	30 313	304	29 600
Ontario	6	755	x	x	x	x	x	x	x	x
Manitoba	87	10 563	x	x	x	x	x	x	x	x
Saskatchewan	11	1 601	x	x	x	x	x	x	x	x
Alberta	56	12 454	72	13 930	78	15 221	78	15 150	66	12 770
British Columbia	4	110	x	x	–	–	–	–	–	–
Total	643	63 772	738	80 152	662	75 484	736	82 832	695	77 229

Source: Energy, Mines and Resources Canada.

[1] Shipments of peat for Prince Edward Island are included in Nova Scotia.

p Preliminary; - Nil; x Confidential; r Revised.

TABLE 4. CANADIAN DOMESTIC EXPORTS OF PEAT, BY COUNTRY, 1985–89p

Country	1985		1986		1987		1988		Jan.-Sept. 1989	
	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value
		($000)		($000)		($000)		($000)		($000)
Angola	–	–	–	–	–	–	–	–	7	6
Anguilla	–	–	–	–	–	–	1	2	30	21
Australia	10	9	61	32	480	251	2 723	1 403	1 623	568
Austria	–	–	–	–	–	–	171	77	–	–
Barbados	20	8	–	–	104	11	5	6	–	–
Belgium	–	–	–	–	–	–	497	147	32	20
Bermuda	70	22	40	15	52	13	66	33	56	11
Chile	8	2	–	–	–	–	–	–	–	–
China, People's Republic	–	–	–	–	–	–	25	3	24	6
Costa Rica	85	12	11	3	–	–	16	6	–	–
Cuba	5	3	1	2	–	–	–	–	–	–
Denmark	–	–	–	–	53	26	27	69	30	86
Dominican Republic	–	–	35	15	14	2	14	6	36	6
Egypt	–	–	–	–	27	15	404	152	–	–
France	–	–	–	–	9	5	19	27	16	38
Finland	–	–	–	–	7	1	–	–	–	–
Germany, West	11	5	35	14	10	4	502	182	79	14
Greece	–	–	–	–	64	33	1 220	425	–	–
Greenland	14	8	38	7	18	7	–	–	–	–
Haiti	92	71	143	121	49	33	49	51	12	7
Honduras	30	23	–	–	–	–	–	–	–	–
Hong Kong	20	3	116	18	237	55	45	9	86	18
Iceland	–	–	–	–	–	–	9	2	50	9
India	17	1	–	–	–	–	–	–	12	8
Ireland	–	–	–	–	11	3	9	2	–	–
Israel	–	–	–	–	63	16	417	101	155	36
Italy	–	–	–	–	17	5	277	71	16	47
Japan	21 029	4 523	31 552	7 240	35 008	7 659	52 691	11 020	39 933	8 875
Jordan	–	–	–	–	–	–	–	–	213	100
Korea, South	30	7	50	12	67	16	154	44	228	71
Kuwait	265	82	–	–	40	27	–	–	31	14
Leeward–Windward Islands	6	1	12	6	22	10	–	–	–	–

TABLE 4. (cont'd)

Country	1985		1986		1987		1988		Jan.-Sept. 1989	
	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value	Tonnage	Value
		($000)		($000)		($000)		($000)		($000)
Mexico	–	–	–	–	–	–	77	16	16	5
Namibia	–	–	–	–	–	–	21	4	–	–
Netherlands	–	–	17	5	204	45	2 718	539	4 449	111
Netherlands Antilles	–	–	–	–	–	–	13	6	–	–
New Caledonia	–	–	–	–	–	–	–	–	2	3
Niger	–	–	–	–	–	–	139	31	–	–
Norway	–	–	–	–	11	2	47	18	–	–
Panama	22	8	–	–	–	–	–	–	–	–
Puerto Rico	1 339	264	2 138	553	1 736	536	2 018	517	2 343	451
St. Kitts–Nevis	–	–	–	–	–	–	19	4	–	–
St. Lucia	–	–	–	–	–	–	73	38	5	2
St. Pierre and Miquelon	–	–	209	38	–	–	–	–	–	–
Saudi Arabia	77	20	576	217	299	55	5 593	1 572	1 921	566
Singapore	15	6	16	7	64	26	–	–	–	–
South Africa	321	81	299	59	300	68	393	119	359	102
Spain	–	–	–	–	–	–	100	11	50	14
Switzerland	–	–	–	–	–	–	56	50	8	23
Taiwan	24	6	–	–	108	37	166	70	86	24
Trinidad – Tobago	63	51	46	15	29	19	15	6	4	10
United Kingdom	–	–	–	–	3 426	960	510	158	7	10
United States	422 937	78 446	499 608	101 574	434 813	93 279	618 678	86 556	456 820	69 396
Virgin Islands	11	6	–	–	–	–	–	–	–	–
Total	446 521	83 668	535 003	109 953	477 342	103 219	689 977	103 553	508 739	80 695

Sources: Statistics Canada. Energy, Mines and Resources Canada.
p Preliminary; – Nil.
Note: Totals may not add due to rounding.

TABLE 5. PRIMARY DESTINATIONS FOR CANADIAN PEAT DELIVERIES FROM MAJOR PRODUCING REGIONS IN 1987

	Canadian Producing Region		
Destinations	Western Canada[1]	Central Canada[2]	Atlantic Canada[3]
		(tonnes)	
Western Canada[1]	15 093	0	96
Central Canada[2]	0	86 752	27 180
Atlantic Canada[3]	0	0	12 567
Subtotal, Canada	15 093	86 752	39 843
United States	140 472	198 695	183 291
Japan	1 051	521	21 858
Other	0	577	1 030
Subtotal, exports	141 523	199 793	206 180
Total	156 616	286 545	246 023

Source: Energy, Mines and Resources Canada.
[1] British Columbia, Alberta, Saskatchewan and Manitoba. [2] Ontario and Quebec. [3] New Brunswick, Prince Edward Island, Nova Scotia and Newfoundland.

TABLE 6. PEAT RESOURCES OF CANADA

	Peatland Areas		Indicated Volume of Peat (Oven Dry)
	Ha x 10^3	% of Total Canadian Peatlands	Tonnes x 10^6
Newfoundland - Labrador	6 429	6	24 945
Prince Edward Island	8	...	30
New Brunswick	120	...	466
Nova Scotia	158	...	613
Quebec	11 713	11	40 057
Ontario	22 555	20	77 138
Manitoba	20 664	19	58 893
Saskatchewan	9 309	8	26 532
Alberta	12 673	11	36 118
British Columbia	1 289	1	4 410
Northwest Territories	25 111	23	65 841
Yukon Territory	1 298	1	2 960
Total	111 328	100	338 003

Source: "Peat Resources of Canada", C. Tarnocai, Agriculture Canada, NRCC 24140, 1984.
... Amount too small to be expressed; Ha Hectare.

Phosphate

1989

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INTRODUCTION

Naturally occurring rock deposits are the most common source of phosphorus; other sources are bones, guano and some types of iron ores that yield by-product basic slag containing sufficient phosphorus to warrant grinding and marketing.

Phosphate rock contains one or more suitable phosphate minerals, usually calcium phosphate, in sufficient quantity for use, either directly or after benefication, in the manufacture of phosphate products. Sedimentary phosphate rock, or phosphorite, is the most widely used phosphate raw material. Igneous and metamorphic rocks which contain apatite are second in importance.

Phosphate rock is graded either on the basis of its P_2O_5 equivalent (phosphorus pentoxide) or its $Ca_3(PO_4)_2$ content (tricalcium phosphate of lime or bone phosphate of lime - TPL or BPL). For comparative purposes, 0.458 unit P_2O_5 equals 1.0 unit BPL, and 1 unit of P_2O_5 contains 43.6% phosphorus.

Approximately 88% of world phosphorus production goes into fertilizers; other products which require the use of phosphorus include organic and inorganic chemicals, soaps and detergents, pesticides, insecticides, alloys, animal-feed supplements, motor lubricants, ceramics, beverages, catalysts, photographic materials and dental and silicate cements.

In 1989 world phosphate rock production was estimated at 162 Mt, or about 3 Mt lower than in 1988. Comparison with previous years must be done cautiously as for the last two years there has been an upward revision of some 6 Mt for production in China. Stocks held by major western world producers were 19.2 Mt at the end of September 1989 compared to 17.0 Mt a year before.

There are currently 32 countries producing phosphate rock with outputs ranging from a few thousand tonnes to 49 Mt. The major producers are the United States, the U.S.S.R., Morocco and China, accounting for 75% of the total output. In 1989, most countries produced at levels similar to 1988 except for a higher production in the United States and Jordan, and a substantially lower production in Morocco and Brazil. The International Fertilizer Industry Association Ltd. reported that the world phosphoric acid trade declined to about 2.6 Mt P_2O_5 in 1989 from 4.1 Mt in 1988 due to the long lasting pricing dispute and consequent disruptions in deliveries between India and its largest suppliers. Lower shipments of superphosphoric acid to the U.S.S.R. were also recorded. By sharp contrast, India tripled its diammonium phosphate (DAP) imports, benefitting principally U.S. exporters.

OCCURRENCES IN CANADA

Known Canadian deposits are limited and fall into three main categories: apatite deposits within Precambrian metamorphic rocks located in eastern Ontario and southwestern Quebec; apatite deposits in some carbonate-alkaline complexes (carbonatites) in Ontario and Quebec; and late Paleozoic - Early Mesozoic sedimentary phosphate rock deposits in the southern Rocky Mountains. Phosphatic mineralization was also reported in the layered rocks of the Athabasca series in Alberta.

The deposit of greatest economic significance is the Kapuskasing (Cargill) phosphate deposit, where early studies indicated the presence of about 62 Mt of ore grading 19.6% P_2O_5. It has been determined that the deposit contains higher-grade sections totalling 22 Mt grading 27.5% P_2O_5. The best part of the deposit contains 6 Mt grading 33% P_2O_5. This material only requires the washing away of the clay fraction.

Another important carbonatite deposit was discovered in 1982 near Martison Lake north of Hearst, Ontario. Higher-grade zones of the deposit contained 57 Mt grading 23% P_2O_5.

In July 1984, Sherritt Gordon Limited, Campbell Resources Inc. and New Venture Equities Ltd. combined to form a joint venture on two phosphate properties at Cargill and Martison Lake in Ontario. In 1987, Jacobs Engineering Group Inc. and Blue, Johnson and Associates completed a feasibility study for the Ontario Ministry of Northern Development and Mines. The study concluded that the deposit may become the base for a viable mining operation of approximately 500 000 t/y in the 1990s when supply and demand for phosphate rock are in balance and if prices improved substantially.

In May 1989, Newphos Limited, a subsidiary of Central Capital Corporation, acquired the right held by Campbell Resources Inc. for both deposits for $1 million and a 4% royalty on future production. Newphos Limited also agreed to undertake a production feasibility study within 24 months, which will be carried out by Kilborn Engineering Limited for completion in the spring of 1990. Meanwhile, in the fall of 1989, a pilot de-sliming mill installed at the Cargill deposit processed in excess of 4000 t of high-grade product grading in excess of 36% P_2O_5. The rock was trucked to Hearst and sent by rail for testing to the Sherritt Gordon fertilizer plant at Fort Saskatchewan, Alberta. It is expected that the tests will take place in February 1990. The development of the Cargill deposit could become a viable proposition once phosphate prices improve in the mid-1990s. Costs of production for a high-grade product will be low, but the main impediment is transportation costs to plants that manufacture fertilizers. Transport costs are likely to be more than double the expected production costs.

CANADIAN PHOSPHATE INDUSTRY

Phosphate Rock and Phosphate Fertilizers

In 1988, Canada imported 2.16 Mt of phosphate rock. For the first ten months of 1989, imports were only 1.52 Mt, mainly from Togo and Florida. Over 80% of the phosphate rock is imported for fertilizer production and the remainder for elemental phosphorus. By the end of 1989, only four fertilizer plants were in operation and Canada's wet phosphoric acid capacity declined to 647 300 t P_2O_5. Back in 1982, nine plants had a combined capacity of 1 140 000 t P_2O_5. Production of phosphoric acid in fertilizer year 1988-89 was 500 571 t P_2O_5 equivalent.

Three phosphate fertilizer plants produce wet phosphoric acid by the dihydrate process in which 28-30% P_2O_5 acid is the principal product and gypsum is the waste product. One plant was converted to a hemihydrate operation.

All phosphoric acid plants in Canada are integrated to produce phosphatic fertilizers, mainly ammonium phosphates. Ammonium phosphates are produced by a neutralization reaction of phosphoric acid with ammonia and, depending on the proportions of the original constituents, either diammonium phosphate (DAP) (18-46-0) or monoammonium phosphate (MAP) (range from 11-48-0 to 11-55-0) is produced. Another common grade, particularly in the west, is the 16-20-0.

Brunswick Mining and Smelting Corporation Limited, through its Smelting and Fertilizer Division (formerly Belledune Fertilizer Limited), produced approximately 129 200 t of DAP in 1989 at its New Brunswick fertilizer plant from rock imported from Florida. The plant was shut down in mid-June for about 2 1/2 months for inventory control and maintenance. It was converted to the hemihydrate process in 1986. In 1988, the plant changed to propane fuel which caused some temporary production difficulties.

Cominco Ltd. produced less than 100 000 t of phosphatic fertilizers in 1989 (MAP and 16-20-0) from its Trail plant in British Columbia. The plant operated on a year-round basis, but much below normal capacity levels since a large part of the sulphuric acid from the smelter was sold directly on the U.S. markets. Cominco's mine in Montana is the main supplier of rock for the Trail plant.

Sherritt Gordon Limited ran its Fort Saskatchewan (Alberta) plant nearly at full capacity throughout 1989, using Florida rock and producing over 100 000 t of MAP. The plant will test some rock from the Cargill deposit in Ontario in early 1990.

Esso Chemical Canada operated its large Redwater (Alberta) plant throughout 1989, except for a three-week planned maintenance shutdown and a one-week inventory correction shutdown in September. A decision was made in mid-1988 to sign a five-year contract for the exclusive supply of Togo rock. It is a high-grade rock averaging over 80% BPL which provides for efficiency benefits.

Elemental Phosphorus

Tenneco Canada Inc., a subsidiary of Tenneco, Inc., controls the Canadian elemental phosphorus producer, Albright & Wilson Americas Inc. (A&WA). The company operated two thermal reduction plants in Canada where elemental phosphorus is produced by the smelting of a mixture of phosphate rock, coke and silica. One tonne of elemental phosphorus (expressed as P_4) requires the input of about 10 t of phosphate rock

(60-67% BPL), 2 t of coke and 3 t of silica. Energy consumption is about 13 000 kWh/t of phosphorus.

Albright & Wilson Americas Inc. closed its Newfoundland, Long Harbour plant on August 5, 1989. The closure resulted in a loss of about 280 jobs. At the end of 1989, 46 persons remained on the payroll. For environmental reasons the company will continue to operate a small electric furnace for a few years to process "mud" stockpiled on site and to produce about 10 t per week of phosphorus. The Government of Newfoundland is currently conducting an environmental impact study on the plant's closure and its clean-up. The Long Harbour plant had an original capacity of 60 000 t/y.

The other A&WA facility, with a 22 500 t/y elemental phosphorus capacity, is located at Varennes, Quebec. The plant operated near optimum capacity levels and shipped most of its product to the parent company's downstream operations at Buckingham, Quebec and at Port Maitland, Ontario. Elemental phosphorus at those two plants is used to produce technical and food grade phosphoric acid (95% H_3PO_4) and amorphous red phosphorus.

PRICES

Most phosphate rock is purchased at prices negotiated between consumers and producers which differ from listed prices in consideration of volume, transportation conditions and local competitive conditions. The average unit price of phosphate rock sold or used in the United States for domestic consumption was US$21.34/t f.o.b. mine in the fertilizer year ending June 30, 1989. Exported rock was US$27.38/t f.o.b. Tampa. These prices compare to US$18.75/t and US$24.08/t respectively in 1988, which indicate a small improvement in price after several years of stagnation.

OUTLOOK

The outlook for 1990 is for a continuation of demand at the current levels, ample supply and prices that will continue the moderate improvement that began in 1989. Significant price improvements are not to be expected until supply and demand approach a balance, which may not be before the 1992-93 period. A leading consulting firm forecasts a rapid increase in the unit price of phosphate rock (basis 70% BPL) to approximately US$45/t in 1995 from the current US$27/t f.o.b. vessel Tampa. Although the timing may be a little too optimistic, as prices approach that level, a deposit such as Cargill could become a viable development.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, PHOSPHATE ROCK IMPORTS, 1988 AND 1989, AND CONSUMPTION, 1987-89

		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports					
2510.10	Natural calcium phosphates, aluminum calcium phosphates, etc., unground				
	Togo	670 878	37 344	681 658	31 409
	United States	784 955	22 617	530 835	16 668
	Senegal	14 400	220	9 500	228
	Morocco	62 305	2 195	-	-
	Total	1 532 540	62 377	1 221 993	48 305
2510.20	Natural calcium phosphates, aluminum calcium phosphates, etc., ground				
	United States	529 363	21 687	205 887	9 620
	Taiwan	-	-	112	6
	Hong Kong	11	...	24	...
	Togo	74 746	4 004	-	-
	Morocco	20 749	736	-	-
	United Kingdom	15	25	-	-
	Total	624 886	26 455	206 023	9 627

	1987	1988p	1989e
	(tonnes)		
Consumption			
Eastern Canada	775 650	774 309	630 000
Western Canada	1 287 060	1 253 541	1 234 000
Total	2 062 710	2 027 850	1 864 000

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; e Estimated; - Nil; ... Amount too small to be expressed.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, TRADE IN SELECTED PHOSPHATE PRODUCTS, 1988 AND 1989

		1988		Jan.-Sept. 1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Imports					
2835.25	Calcium hydrogenorthophosphate (dicalcium phosphate)				
	United States	33 974	13 737	49 149	19 458
	Other countries	977	861	868	674
	Total	34 951	14 598	50 017	20 132
2835.26	Calcium phosphates, n.e.s.				
	United States	42 781	16 857	39 085	14 155
	Other countries	187	160	176	192
	Total	42 968	17 017	39 261	14 347
Fertilizers					
3103.10.00.10	Superphosphates containing 22% or less by weight of phosphorus pentoxide (simple superphosphate)				
	United States	7 849	1 699	1 528	308
	Total	7 849	1 699	1 528	308
3103.10.00.20	Superphosphates containing more than 22% by weight of phosphorus pentoxide (triple superphosphate)				
	United States	61 318	13 319	32 350	6 960
	Total	61 318	13 319	32 350	6 960
3105.30	Diammonium phosphate in packages weighing less than 10 kg				
	United States	196 609	47 142	106 776	23 793
	Belgium	530	234	439	302
	Total	197 139	47 376	107 215	24 096
3105.40	Monoammonium phosphate and mixtures thereof with diammonium phosphate, in packages less than 10 kg				
	United States	196 756	50 931	150 793	36 997
	Belgium	2 008	1 119	948	610
	Israel	52	30	130	77
	Other countries	171	94	118	68
	Total	198 987	52 174	151 989	37 752
Chemicals					
2835.23	Trisodium phosphate				
	United States	359	420	287	350
	People's Republic of China	171	139	156	85
	West Germany	14	15	91	46
	Other countries	103	71	85	54
	Total	647	645	619	535
2835.24	Potassium phosphates				
	United States	2 096	2 344	1 527	1 723
	Israel	220	226	350	344
	West Germany	64	71	16	22
	Other countries	20	20	7	10
	Total	2 400	2 661	1 900	2 099
Exports					
3105.30	Diammonium phosphate, in packages weighing less than 10 kg				
	Spain	10 287	2 471	24 359	5 470
	United States	10 865	2 743	10 438	2 695
	Jamaica	7 825	2 364	7 289	2 079
	Puerto Rico	-	-	2 744	551
	Total	28 977	7 578	44 830	10 797
3105.40	Monoammonium phosphate and mixtures thereof with diammonium phosphate, in packages less than 10 kg				
	United States	67 762	14 310	32 143	7 244
	Other countries	20	4	20	8
	Total	67 782	14 314	32 163	7 252

Source: Statistics Canada.
^{p} Preliminary; n.e.s. Not elsewhere specified; - Nil.

TABLE 3. CANADA, PHOSPHATE FERTILIZER SHIPMENTS, 1983–89[1]

	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89
	(tonnes P_2O_5 equivalent)					
Domestic markets:						
Atlantic Provinces	24 965	26 894	20 360	(	(	
Quebec	37 835	27 990	23 865	(58 632[2]	(438[3]	197
Ontario	79 160	52 843	39 287	(	(	
Manitoba	90 529	92 092	90 354	77 856	86 342	81 353
Saskatchewan	195 170	182 017	184 306	163 352	153 599	141 353
Alberta	161 185	170 943	153 523	132 087	133 114	149 512
British Columbia	11 311	11 940	10 951	10 056	8 893	9 045
Total Canada	600 155	564 719	522 646	441 983	382 377	381 474
Export markets:						
United States	65 790	71 403	46 763	51 344	28 966	30 790
Offshore	4 652	12 743	17 021	9 427		
Total exports	70 442	84 146	63 784	60 771	89 431	30 790
Total shipments	670 597	648 865	586 430	502 754	471 805[4]	467 933[4]

Source: Canadian Fertilizer Institute.

[1] Fertilizer year: July 1 to June 30; not 100% industry coverage. [2] Atlantic Provinces, Quebec and Ontario now disclosed as total only. [3] DAP data withheld to prevent individual disclosures. [4] Total includes amounts under-reported in domestic and export markets.

TABLE 4. CANADA, PHOSPHATE FERTILIZER PLANTS, 1989

Company	Plant Location	Annual Capacity	Principal End Products	Source of Phosphate Rock	Basis for H_2SO_4 Supply for Fertilizer Plants
		(tonnes P_2O_5 equivalent)			
Eastern Canada					
Belledune Fertilizer div. of Noranda Inc.	Belledune, New Brunswick	150 000	am ph	Florida	SO_2 smelter gas
		150 000			
Western Canada					
Cominco Ltd.	Trail, British Columbia	77 300	am ph	Montana	SO_2 smelter gas
Esso Chemical Canada	Redwater, Alberta	370 000	am ph	Togo	Sulphur
Sherritt Gordon Limited	Fort Saskatchewan, Alberta	50 000	am ph	Florida	Sulphur
		497 300			

P_2O_5 equivalent - Phosphorus pentoxide equivalent; am ph Ammonium phosphates.

TABLE 5. WORLD PHOSPHATE ROCK PRODUCTION, 1986–89

	1986	1987	1988	1989^{e}
	(000 tonnes product)			
WORLD TOTAL	**144 522**	**153 970**	**164 957**	**162 000**
West Europe	**722**	**793**	**784**	**750**
Finland	510	527	583	
Sweden	187	192	127	
Turkey	37	3	74	
East Europe	**36 436**	**37 586**	**38 820**	**39 000**
U.S.S.R.	36 436	37 586	38 820	
North America	**38 889**	**40 750**	**46 596**	**48 500**
United States	38 884	40 750	46 596	
Central America	**600**	**640**	**655**	**650**
Mexico	600	640	655	
South America	**4 541**	**4 874**	**4 867**	**4 200**
Brazil	4 509	4 777	4 672	
Colombia	27	34	35	
Peru	5	63	60	
Venezuela	173	100	100	
Africa	**36 904**	**36 842**	**42 113**	**36 800**
Algeria	1 203	1 073	1 332	
Egypt	1 272	1 103	1 146	
Morocco Sahara	21 178	20 955	24 783	
Senegal	1 851	1 880	2 296	
South Africa	2 991	2 623	2 850	
Togo	2 314	2 644	3 464	
Tanzania	10	18	15	
Tunisia	5 951	6 390	6 103	
Zimbabwe	134	156	124	
Asia	**24 586**	**24 921**	**29 076**	**30 700**
China	9 790	9 000	15 000	
Christmas Island	825	842	-	
India	527	553	657	
Iraq	1 100	1 100	1 273	
Israel	3 673	3 798	3 449	
Jordan	6 249	6 801	5 666	
North Korea	500^{e}	500	500	
Pakistan	50	33	36	
Syria	1 606	1 986	2 342	
Vietnam	300^{e}	320	600	
Sri Lanka	15	21	23	
Oceania	**1 529**	**1 386**	**1 546**	**1 400**
Australia	35	10	6	
Nauru	1 494	1 376	1 540	

Sources: Phosphate Rock Statistics, International Fertilizer Industry Association Ltd.; U.S. Bureau of Mines, Mineral Commodity Summaries.

^{e} Estimated. - Nil

Note: Totals may not add due to rounding.

Platinum Metals

1989

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The platinum group metals (PGMs) refer to six closely related metals: platinum, palladium, rhodium, ruthenium, iridium and osmium. These metals, among the scarcest of all metallic elements, commonly occur together in nature.

In 1989, overall industrial demand for platinum in the non-socialist world was expected to increase by more than 5% over 1988 levels. The largest gains were recorded in the automobile catalyst market, despite a slowdown in the U.S. automotive industry in the second half of the year. On the other hand, investment demand fell dramatically in response to the attractiveness of alternative investments combined with the easing of concerns about inflation and the reliability of supplies from the Republic of South Africa. While platinum prices were generally lower in 1989 compared to the previous year, there was no discernable trend in price movements.

On the basis of speculation at the beginning of 1989 that palladium might replace platinum in three-way automobile catalysts, followed in March by reports that the metal was used in cold fusion experiments, palladium prices in April climbed to their highest level since 1980. However, in view of the likelihood that palladium would not replace platinum for auto-catalyst applications in the immediate future combined with growing scepticism of cold fusion research, this period of elevated prices was relatively short-lived. Despite these disappointments, overall palladium demand in 1989 was expected to match the record levels achieved in 1988.

At the end of 1989, rhodium prices skyrocketed in response to production problems in South Africa and reduced supplies from the U.S.S.R. The strong growth of rhodium consumption for three-way automobile catalysts in recent years is expected to continue in the 1990s as new automobile emission regulations are introduced or existing regulations are strengthened.

CANADIAN DEVELOPMENTS

The production of PGMs in Canada in 1989 is estimated to have fallen to 10 375 kg from the revised output figure of 12 541 kg for 1988. While the bulk of Canadian production is derived from the operations of Inco Limited and Falconbridge Limited in the Sudbury basin in Ontario, small amounts are also produced from Inco's operations at Thompson, Manitoba and the Namew Lake mine (Hudson Bay Mining and Smelting Co., Limited (HBMS) and Outokumpu Mines Ltd.), also in Manitoba.

Preproduction work continued at the Lac-des-Îles palladium/platinum property in northwestern Ontario, being developed by Madeleine Mines Ltd. While the company has not announced a firm start-up date, production could begin in 1990. At an initial mining rate of 2700 t/d, the company expects the operation to have an annual output of 4665 kg of PGMs, 625 kg of gold and 900 t each of copper and nickel. Estimated reserves on the targeted Roby zone are more than 20 Mt grading 6.4 g/t PGM, with a platinum-to-palladium ratio varying between 1:4 and 1:8.

There was a significant drop in PGM exploration in Canada in 1989 despite the fact that prices remained relatively high. As in the case of gold, one of the principal reasons for the decline was the reduced availability of risk capital to mining companies.

Despite the overall decline of exploration, work was carried out at a number of PGM properties across Canada. In Ontario, Euralba Mining (Canada) Ltd. continued work at the Marathon deposit optioned from Fleck Resources Ltd. At Big Trout Lake in northwestern Ontario, International Platinum Corporation reported the discovery of promising new PGM mineralization. The company also continued with its exploration program on the Muskox Intrusion in the Coppermine River area. Both programs were jointly funded by Degussa AG and Jenkim Holdings (Canada) Limited.

A preliminary feasibility study commissioned by All-North Resources Ltd. (59% owned by Galactic Resources Ltd.) concluded that the company's Wellgreen property in the Yukon was exploitable using low-cost open-pit mining methods. Current probable reserves at the property are estimated at 42.3 Mt grading 0.36% nickel, 0.35% copper, 0.5 g/t platinum and 0.3 g/t palladium.

In Quebec, La Fosse Platinum Group Inc. continued its platinum exploration program in the Labrador Trough, with the bulk of activity centred on the Blue Lake and Gerido Lake areas.

Platinum Lake Technology Inc. of Toronto successfully operated a prototype plant to recover platinum group metals from spent automobile catalysts using its proprietary CRO/REDOX hydrometallurgical process. The prototype plant has a capacity to handle 5 t/d of platinum-bearing material. In addition to the company's work in further defining the commercial operating parameters of the technology for the recovery of PGMs from auto catalyst scrap, Platinum Lake continued research on applications of the process to other secondary as well as primary source materials.

WORLD DEVELOPMENTS

The major world producers of the platinum group metals are the Republic of South Africa (48%), the U.S.S.R. (44%), Canada (4.5%) and the United States (2%). Other producers include Finland, Yugoslavia, Ethiopia, Zimbabwe, Japan (from imported nickel and copper ores and intermediates), the People's Republic of China, Colombia and Australia. In 1989, world production, excluding China, was estimated at 282 t, an increase of about 2.5% over 1988.

At the end of 1989, there were six PGM producers in the Republic of South Africa: Rustenburg Platinum Holdings Limited controlled by Johannesburg Consolidated Investment Company, Limited (JCI); Lebowa Platinum Mines Limited, with linkages to both Rustenburg and JCI; Impala Platinum Holdings Ltd., controlled by General Mining Union Corporation Limited (Gencor); Western Platinum Limited and Eastern Platinum Limited, owned by Lonhro Plc; and Barplats Mines Limited, controlled by Rand Mines Limited.

Rustenburg, the largest South African producer, operates three mines on the western rim of the Bushveld complex, namely the Rustenburg Section, the Union Section and the Amandelbult Section, and also manages another, the Atok mine, in the extreme northeast of the Bushveld Complex, on behalf of its affiliate, Lebowa Platinum Mines Limited. Capacity of the Rustenburg operations, including Lebowa, is estimated at about 40 500 kg/y of platinum. During 1989, both Rustenburg and Lebowa continued work on several expansion projects in South Africa. At Rustenburg, this included an expansion of the Amandelbult Section mine and improvements to the Rustenburg Section concentrator. The two projects are expected to increase total platinum output by at least 4500 kg/y over the next three years. At Lebowa's Atok mine, work is proceeding on an expansion that will increase capacity from about 2000 kg to 3000 kg/y of platinum by August 1991 and to over 4000 kg/y by mid-1992.

In March, workers at Rustenburg's base-metal refinery in South Africa went on strike after a breakdown of wage negotiations. Although the labour dispute lasted for almost three months, the company reported that normal production was maintained at the plant. In September, Rustenburg announced that it was withdrawing from a joint project with Lebowa to develop a new mine at Maandagshoek in the tribal homeland of Lebowa. However, the two companies did announce that they were considering a new joint venture to develop a mine on the Platreef, near the town of Potgietersrus.

After significant delays, Rustenburg's new precious metals refinery in Bophuthatswana began operations in March 1989. At the end of 1989, it was reported that the facility, which was built as a replacement for refineries at Wadeville in South Africa and Royston in the United Kingdom, was experiencing production problems, particularly with regard to the output of rhodium. It is estimated that Rustenburg accounts for about one third of the 9500 kg of rhodium produced in the world each year.

Impala Platinum Holdings Ltd., the second largest PGM producer in the Republic of South Africa, operates four mines, northwest and adjoining the Rustenburg Section mine. Impala's annual platinum capacity is estimated at about 34 000 kg/y. In September, about one third of the workforce at Impala's precious metals refinery at Springs staged a four-day work stoppage to protest parliamentary elections in the Republic of South Africa. The company reported that there were no production losses. At the end of 1989, it was announced that the first phase of the new Karee mine operated by

Impala's subsidiary, Gazelle Platinum Limited, was in the process of being commissioned. The mine will have an initial capacity of about 3000 kg/y of platinum, increasing to approximately 4500 kg/y by 1994.

During 1989, Impala continued negotiations to gain control of Messina Ltd. from Sanlam Insurance Corp. Messina holds the mineral rights to property on the northeastern rim of the Bushveld Complex in Lebowa on which another new platinum metals mine is likely to be developed. Ore reserves at this site are estimated at 26 Mt grading 5.9 g/t PGMs plus gold for the Merensky reef and 33.8 Mt grading 6.7 g/t for the UG2 reef.

Western Platinum Limited, with one mine near Marikana, east of the Rustenburg Section, is the third largest South African producer. The company's platinum capacity is estimated at about 5000 kg/y, although an expansion to approximately 8500 kg/y is planned. During 1989, Western's affiliate, Eastern Platinum Limited, began production at its new platinum metals mine in Bophuthatswana. This operation, which will have planned capacity of about 5000 kg/y of platinum, is expected to be fully on-stream in 1991.

In January 1990, it was announced that Impala would merge its Karee mine with Western Platinum Limited. As a result of the transaction, Impala will acquire a 25% interest in Western Platinum as well as a 27% share of future earnings of both the merged assets and Eastern Platinum Limited.

In the first quarter of 1989, Barplats Mines Limited brought its new Crocodile River mine (formerly the Lefkochrysos property) into production. In April, Barplats produced its first smelter matte from its processing plant, also at Crocodile River, while the first refined platinum was produced in June at the company's new refinery at Brakpan. It is expected that the operation will reach an output level of about 5300 kg/y of platinum in the first quarter of 1990 with production increasing to 8300 kg/y by the end of 1992. Barplats also continued work during 1989 on the development of its Kennedy's Vale property (formerly called Rhodium Reefs). It is expected that this mine will come on-stream in 1995 at a production rate of between 4000 and 5500 kg/y of platinum.

During 1989, Northam Platinum Limited, controlled by Gold Fields of South Africa Ltd., continued development work on a new platinum metals mine located on the southeastern boundary of Rustenburg's Amandelbult Section mine. It is expected that production will begin at the end of 1991 although the operation will not reach its full design capacity of about 7000 kg/y until 1994.

In Zimbabwe, PGM exploration continued during 1989 on the Hartley Complex of the Great Dyke. In November, Delta Gold NL completed a feasibility study of its Hartley platinum project, 65 km south of Harare. The proposed development, which would have an output of about 5600 kg/y of PGMs plus gold, nickel and copper, could come on-stream in 1992. The cost of the project is estimated at US$185 million. Also on the Hartley Complex, there were several other exploration projects during 1989 involving Rio Tinto Zimbabwe Ltd. and Anglo American Corp. Zimbabwe Ltd.

Also in Africa, Molopo Australia Ltd. and Inco Limited signed a joint venture agreement in November to explore the former's platinum concessions in the Republic of Botswana.

The Stillwater Mining Company, jointly owned by Chevron Resources Company and Manville Corporation, is the only primary PGM producer in the United States. The mine, which came on-stream in 1987, was expected to produce approximately 5800 kg of combined platinum and palladium in 1989, increasing to 7300 kg in 1990 with the completion of a major expansion. The company is also considering the development of a second mine 20 miles to the west of the current operation.

Stillwater plans to build a smelter at the mine site in an attempt to reduce costs and shorten the period of time between actual production and the receipt of payment for mine output. At the end of 1989, the company was awaiting environmental approval for the project, which is expected to cost about US$6 million.

In Australia, platinum exploration continued at a large number of sites during 1989. In Western Australia alone, it was reported that there were 85 exploration projects involving more than 40 companies. Some of the more promising areas include Yarawindah Brook, Munni Munni and Panton Sill. Other promising areas include Coronation Hill in the Northern Territory and Fifield in New South Wales.

In eastern Greenland, Platinova Resources Ltd. and Corona Corporation continued exploration work on the Skaergaard intrusion, where promising indications of significant gold and platinum mineralization have been reported.

Elsewhere, Brazil's state-owned mining exploration company, Cia de Pesquis de Recursos Minerais, announced the discovery of platinum near Canine while the Ministry of Petroleum and Minerals of the Sultanate of Oman announced the discovery of a platinum deposit in the northern part of the country.

RECYCLING

The recovery of PGMs from secondary sources such as used industrial catalysts, electronic scrap and jewellery constitutes an important source of these metals. The U.S. Bureau of Mines reported that the United States produced over 51 t of secondary PGMs in 1988, including 24 t of platinum and 24.5 t of palladium.

Spent automobile catalysts represent a growing and potentially significant source of PGMs. Johnson Matthey Public Limited Company estimated that the recycling of these catalysts would yield about 5400 kg of platinum and 2300 kg of palladium in 1989. This compares to 5000 kg of platinum and 2000 kg of palladium in 1988.

According to Shearson Lehman Hutton Inc., it is not cost-effective to recover the platinum from scrapped auto catalysts when bullion prices are less than US$475/oz.

CONSUMPTION AND USES

Platinum group metals are used in a wide variety of applications in pure form and in a host of alloys combining different PGMs alone or with other metals. The diversity of uses reflects their varied and unique attributes which include: chemical inertness and corrosion resistance, the ability to catalyze chemical reactions, high melting points, high strength at elevated temperatures, stable thermo-electric properties, good durability, low coefficient of thermal expansion, excellent reflectivity, stable electrical contact resistance and good high temperature oxidation resistance. Platinum and palladium are the most common PGMs found in nature. Platinum's principal uses are in catalysts designed to control automobile exhaust emissions and in jewellery, while the main uses of palladium are in the electrical and electronics industries and also in dental alloys.

While the other PGMs are less important in absolute terms, rhodium, iridium and ruthenium have key industrial applications. The most important uses of rhodium are in automobile catalysts and as an alloying agent with platinum, while iridium is used in electrochemical and catalytic applications. The principal uses of ruthenium are electrochemical and electronic in nature. Osmium is used in the chemical and medical fields.

One of the largest uses of PGMs is in the production of automobile catalysts. There are two distinct types of auto catalysts, an oxidation type which controls carbon monoxide and hydrocarbons, and the so-called three-way type which controls emissions of carbon monoxide, hydrocarbons and nitrous oxides. Oxidation catalysts can contain either platinum or palladium although most use a combination of the two metals. On the other hand, three-way catalysts require platinum and rhodium. The use of oxidation catalysts has diminished as new environmental regulations governing nitrous oxides have come into effect, but some automobile manufacturers utilize an oxidation catalyst in conjunction with a three-way catalyst. PGM catalytic units are currently the major technology being utilized to reduce hydrocarbon and nitrous oxide emissions in automotive exhaust gases. Although research is continuing on alternative systems, including the lean-burn engine concept, these are not yet considered to be viable alternatives.

At the end of 1988, Ford Motor Company announced that it had developed a new three-way automobile catalyst that did not utilize platinum. While it was assumed that palladium was the substitute material used by Ford, the importance of the announcement, in terms of any significant shift away from platinum for automobile catalyst applications in the immediate future, was dismissed.

In June 1989, the European Communities adopted new U.S. 1983-type emission standards for all gasoline-powered automobiles under 1.4 litres. These new regulations, which will take effect on January 1, 1993, go significantly beyond the levels agreed upon in 1988. In addition, it is also likely that earlier standards applicable to larger cars will also be made more stringent. In view of these developments, together with the likelihood that stricter California-type standards will be adopted in the United States and that emission regulations will be introduced in other countries such as Brazil, Mexico and Venezuela, the demand for platinum and rhodium will experience significant growth in the next decade.

In April, the Canadian government announced its intention to tighten emission controls. This will include reductions of up to 30% for nitrogen oxides and volatile organic compounds. Carbon dioxide emission levels will likely be held at current levels until 1995 and then reduced by 20% over the period to 2005.

Even before the full implementation of emission standards in Europe, the demand for converter-equipped automobiles has increased dramatically as a result of growing concern by both individuals and governments over the environmental effects of pollution. In an attempt to speed up the conversion to automobiles with catalytic converters, a number of European governments have offered various incentives to the purchasers of automobiles with pollution control devices.

The use of platinum in jewellery constitutes the second largest use for the metal. In 1989, it was expected that platinum demand in this sector would increase by almost 1900 kg due in part to the relative stability of bullion prices. Japan continued to be the largest market for platinum jewellery with 1989 consumption representing about 89% of the western world total.

In the petroleum refining industry, PGMs, particularly platinum, are used as reforming agents to increase the octane rating of gasolines. This use has become more important in recent years as more stringent environmental regulations have restricted the amount of lead additives in gasoline. These additives are known to reduce the effectiveness of PGM auto catalysts. Also in the refining industry, PGM catalysts are used in hydrocracking and isomerization applications. Other important industrial applications of platinum are in the glass industry for the production of glass fibres, in the chemical sector where platinum gauze is used in the production of nitric acid, and in the electrical industry and the biomedical sector.

One potential use, which could represent a major new market for platinum, is in the manufacture of phosphoric acid fuel cells. There are several potentially promising applications for this technology, including stationary power generation systems. While development work for such systems is continuing, they offer significant advantages over traditional systems in terms of potential energy efficiency and cleanliness of operation. In December, it was reported that Nippon Mining Company Limited had established a commercial production technology for a platinum-iron magnet. This magnet is suitable for ultraclean environments because it does not generate gas or dust. The price of the magnet was quoted at US$214/g.

Investment demand has been a large but somewhat erratic market for platinum in recent years. During 1989, it was expected that total investment demand would fall from about 19 600 kg in 1988 to less than 5200 kg. The Royal Canadian Mint reported that sales of the platinum "Maple Leaf" coin in 1989 totalled 467 kg compared to almost 2000 kg during the last six weeks of 1988.

One of the largest markets for palladium is in the electronics industry, where it is used in the manufacture of multi-layer ceramic capacitors, thick-film hybrid integrated circuits, resistor networks and electrical contacts. Another important application and the fastest growing market for palladium is in the field of dentistry, where it is used in dental alloys and orthodontic and prothodontic devices. Much of this growth has resulted from the substitution of palladium for higher-priced gold.

In response to criticism from the U.S. Mint that palladium coinage would be too difficult to produce, a proposal to mint 350 000 commemorative palladium coins in that country was abandoned. However, the U.S.S.R. announced in 1989 that it would produce 30 000 legal tender palladium bullion coins.

Although the promise that cold fusion could provide both a low-cost form of power generation and also a significant market for palladium has been dulled by significant scepticism within the scientific community, research is continuing. Stanford University recently reported that during the electrochemical insertion of deuterium into palladium, heat was produced in an amount equivalent to about 8.5 watts/cm^3 of metal. This compares to 50 watts/cm^3 of core in a large nuclear power plant.

MARKETS PRICES AND STOCKS

After trading at about US$132/oz. during the first half of January, London palladium prices increased to around $145 in mid-March due to projected strong growth for the metal in automobile catalysts. Following reports at the end of March that palladium had been used in an experimental nuclear fusion reaction, prices escalated rapidly, surpassing $180/oz. in April. However, by August, palladium prices had fallen to about $135 in view of the considerable scepticism which had arisen on both cold nuclear fusion and potential commercial applications. For the remainder of the year, palladium prices maintained a trading range of between $135 and $145/oz. The average price of palladium in 1989 was US$144.58 compared to $124.26 in 1988. In January 1990, palladium prices averaged $135.46.

Platinum prices in London, which averaged US$527.34/oz. in January 1989, strengthened through the first part of the year to $555 in April on the basis of projected growth in automotive catalyst markets. Beginning in May, prices deteriorated in response to a strengthening U.S. dollar, falling to $467 in mid-September. Platinum staged a modest recovery in November, rising to over $530/oz., before settling back to an average price of $506.34 in December and $497.91 in January 1990. The average price of platinum in 1989 was $509.64 compared to $530.78 in 1988.

New York dealer prices for rhodium, which averaged US$1265/oz. for the first 10 months of 1989, skyrocketed at the end of the year reaching $2000 in early December as a result of acute physical shortages caused by rapidly increasing demand, production difficulties in the Republic of South Africa and reduced U.S.S.R. rhodium sales. After moderating for the remainder of the month, rhodium reached and surpassed $2000 again in January 1990.

New York dealer prices for ruthenium during 1989 were relatively stable with the metal trading in a range of between US$61 and $67/oz. On the other hand, iridium prices increased slightly from a range of between $295 and $305/oz. to between $310 and $320, while osmium fell from a $580-$625 range to between $475 and $525.

In September, the New York Commodity Exchange filed an application with the Commodity Futures Trading Commission to trade platinum options. An options contract confers the right but not the obligation to buy or sell a futures contract. In October, it was reported that the Tokyo Commodity Exchange was considering the establishment of a palladium futures contract.

In its "Platinum 1989 Interim Review" published in November 1989, Johnson Matthey Public Limited Company estimated a supply deficit of about 3700 kg of platinum in 1989 compared to a shortfall of almost 12 500 kg in 1988. For palladium, Johnson Matthey forecasted a supply deficit of approximately 3100 kg in 1989 compared to only 300 kg in 1988.

OUTLOOK

Although a significant amount of new PGM capacity, particularly in the Republic of South Africa, is expected to come on-stream in the next five years, the strong growth of demand for automobile catalysts throughout the 1990s is likely to exert some upward pressure on platinum prices. In Europe alone, the demand for platinum in catalysts is expected to increase from about 7600 kg in 1988 to over 18 000 kg in 1993.

However, the extent of the price escalation is dependent on a number of factors, the most important of which are political in nature. Despite the recent positive developments within the Republic of South Africa, significant uncertainty remains with regard to the future stability of that country. Moreover, moves toward democracy within South Africa will likely contribute to significant changes in the factors of production for mining and processing operations. With ore thicknesses that can inhibit the mechanization of operations, higher labour rates in South Africa will have a significant impact on mining costs and ultimately on international prices for the platinum group metals.

In addition to the changes in South Africa, political developments in Eastern Europe can also be expected to have an impact on the availability of supplies and price levels. Irrespective of possible increases in the level of by-product PGM output in the U.S.S.R., it is likely that economic reforms will stimulate industrial activity and thereby will reduce the volume of material that can be exported to the western world.

Despite the possibility of supply constraints for primary metal from South Africa or the U.S.S.R., it is expected that there will be a significant increase in the amount of material recovered from recycling in the next decade. This assumes, however, that the use of automobile catalysts continues to grow as expected and that prices justify collection and processing.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. PLATINUM METALS, PRODUCTION AND TRADE, 1988 AND 1989p

Item No.		1988		1989p	
		(kilograms)	($000)	(kilograms)	($000)
Production[1]					
Platinum, palladium, rhodium, ruthenium, iridium		12 541	190 914	10 375	143 853
Exports				(Jan.-Sept.)	
2604.00	- Nickel ores and concentrates				
2604.00.83	----- Platinum metals group content	-	-	-	-
26.16	Precious metal ores and concentrates				
2616.90	- Other				
2616.90.83	---- Platinum metals group content				
	United Kingdom	12 494	134 813	7 178	81 568
	West Germany	-	-	12	367
	United States	-	-	1	130
	Total	12 494	134 813	7 191	82 065
7110.11	Platinum unwrought or in powder form				
	Japan	-	-	1 800	43 818
	United States	234	2 865	779	15 186
	West Germany	62	328	78	1 500
	United Kingdom	579	2 997	-	-
	Other countries	75	562	2	36
	Total	950	6 752	2 659	60 540
7110.19	Platinum in other semi-manufactured forms				
	Australia	4	34	665	10 035
	Hong Kong	391	7 607	117	1 754
	United States	398	8 851	3	26
	Other countries	10	190	4	34
	Total	803	16 682	789	11 849
7110.21	Palladium unwrought or in powder form				
	United Kingdom	1 293	6 372	1 935	11 738
	United States	818	4 778	845	4 879
	France	-	-	249	1 501
	Other countries	142	626	-	-
	Total	2 253	11 776	3 029	18 119
7110.29	Palladium in other semi-manufactured forms				
	United Kingdom	8	17	175	926
	People's Republic of China	-	-	98	487
	Singapore	239	985	-	-
	Other countries	43	204	-	-
	Total	290	1 206	273	1 414
7110.31	Rhodium unwrought or in powder form				
	United Kingdom	321	11	-	-
	Total	321	11	-	-

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(kilograms)	($000)	(kilograms)	($000)
Exports (cont'd)					
7112.20	Waste and scrap of platinum; including metal clad with platinum, except sweepings containing other precious metals				
	United States	43 179	16 707	525 043	27 332
	United Kingdom	87	1 008	154 524	6 140
	Other countries	8 595	604	15 959	1 929
	Total	51 861	18 319	695 526	35 401
Imports					
26.16	Precious metal ores and concentrates				
2616.90.00	- Other				
2616.90.00.30	----- Platinum group metal content				
	United States	-	-	322	3 068
	United Kingdom	17	405	-	-
	Total	17	405	322	3 068
7110.11	Platinum unwrought or in powder form				
	West Germany	-	-	1 269	22 951
	South Africa	210	6 081	590	11 576
	United States	1 318	23 180	158	3 022
	U.S.S.R.	1 584	34 292	190	4 128
	Other countries	40	800	10	203
	Total	3 152	64 353	2 217	41 883
7110.19	Platinum in other semi-manufactured forms				
	U.S.S.R.	3 470	74 895	678	13 905
	United States	1 115	15 268	293	3 166
	South Africa	429	8 831	47	958
	Other countries	389	7 423	53	1 080
	Total	5 403	106 417	1 071	19 109
7110.21	Palladium unwrought or in powder form				
	United States	462	8 084	118	808
	South Africa	-	-	124	571
	Other countries	544	651	30	191
	Total	1 006	8 735	272	1 571
7110.29	Palladium in other semi-manufactured forms				
	United States	621	3 653	727	7 727
	South Africa	103	497	156	821
	Other countries	150	1 019	71	489
	Total	874	5 169	954	9 037

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989^p	
		(kilograms)	($000)	(kilograms)	($000)
Imports (cont'd)					
7110.31	Rhodium unwrought or in powder form				
	South Africa	-	-	68	3 414
	United States	296	4 769	41	1 906
	Other countries	20	830	66	2 678
	Total	316	5 599	175	7 998
7110.39	Rhodium in other semi-manufactured forms				
	United States	37	600	14	543
	United Kingdom	92	226	5	191
	Other countries	-	-	-	-
	Total	129	826	19	734
7110.41	Iridium, osmium and ruthenium unwrought or in powder form				
	United States	5	43	87	1
	Total	5	43	87	1
7110.49	Iridium, osmium and ruthenium in other semi-manufactured forms				
	United States	8	98	8	83
	Total	8	98	8	83
7112.20	Waste and scrap of platinum, including metal clad with platinum but excluding sweepings containing other precious metals				
	United States	889 103	15 744	599 284	5 839
	Mexico	40	87	53 337	901
	Other countries	59	330	557	186
	Total	889 202	16 161	653 179	6 927
71.15	Other articles of precious metal or of metal clad with precious metal				
7115.90	- Other				
7115.90.10.20	----- Crucibles of platinum				
	United States	1 053	30 079	682	19 029
	Canada	. . .	3	32	868
	Other countries	-	-	1	4
	Total	1 053	30 082	715	19 901
7115.90.90	--- Other				
7115.90.90.30	----- Of platinum				
	United States	114	692	69	410
	Total	114	692	69	410

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Platinum metals, content of concentrates, residues and matte shipped for export.

^{p} Preliminary; - Nil; . . . Amount too small to be expressed.

Note: Numbers may not add to totals due to rounding.

TABLE 2. WORLD PRODUCTION OF PLATINUM GROUP METALS, 1985–88

	1985	1986	1987	1988p
		(tonnes)		
EUROPE				
Finland	35	96	89	93
Palladium	35	120	120	124
Platinum				
Yugoslavia•				
Palladium	103	96	100	100
Platinum	8	8	3	3
Subtotal	181	320	312	320
AFRICA				
Ethiopia•				
Placer platinum	5	5	5	5
South Africa				
Platinum group metals	115 000	123 000	131 257	133 278
Zimbabwe				
Palladium	30	35	29	31
Platinum	19	26	18	19
Subtotal	115 054	123 066	131 308	133 333
ASIA				
Japan				
Palladium	1 359	1 453	1 417	1 197
Platinum	691	663	753	650
Subtotal	2 050	2 116	2 170	1 848
AMERICA				
Canada				
Platinum group metals	10 534	12 190	10 930	12 541
Colombia				
Placer platinum	362	447	638	815
United States				
Placer platinum and platinum group metals	w	w	w	w
Subtotal	10 896	12 637	11 568	13 356
AUSTRALIA				
Palladium	476	428	491	411
Platinum	95	115	131	106
Subtotal	571	543	622	516
EASTERN COUNTRIES				
U.S.S.R.•				
Placer platinum and platinum group metals	118 000	120 000	121 000	121 000
WORLD TOTAL	**246 752**	**258 682**	**266 980**	**270 373**

Source: Energy, Mines and Resources Canada.
p Preliminary; • Estimate; w Withheld to avoid disclosing company proprietary data; excluded from "Total."

TABLE 3. PLATINUM SUPPLY AND DEMAND, WESTERN WORLD, 1987–89

	1987	1988	1989•
		(000 grams)	
Supply			
South Africa	78 380	80 246	82 112
Canada	4 354	4 510	4 510
Others	1 244	2 955	2 488
	83 978	87 710	89 110
U.S.S.R. sales	12 441	13 685	13 685
Total	96 419	101 396	102 795
Demand			
Western Europe	17 418	16 951	18 662
Japan	51 320	59 095	50 542
North America	27 993	26 904	27 993
Rest of western world	5 599	9 642	8 087
	102 329	112 593	105 284
Western sales to COMECON China	933	1 244	1 244
Movements in stocks	(6 843)	(12 441)	(3 732)
Total	96 419	101 396	102 795

Source: Johnson Mathey Public Limited Company.
( ) Brackets refer to reduction; • Estimate.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 4. PLATINUM SUPPLY AND DEMAND, WESTERN WORLD, 1987–89

	1987	1988	1989•
		(000 grams)	
Supply			
South Africa	33 902	34 369	35 302
Canada	5 910	5 288	5 754
Others	2 799	8 398	6 998
	42 611	48 054	48 054
U.S.S.R. sales	55 674	55 052	53 653
Total	98 285	103 106	101 707
Demand			
Western Europe	17 107	18 817	19 284
Japan	44 477	47 743	47 121
North America	32 192	31 725	33 125
Rest of western world	5 288	5 132	5 288
	99 063	103 417	104 817
Movements in stocks	(778)	311	3 110
Total	98 285	103 106	101 707

Source: Johnson Matthey Public Limited Company.
( ) Brackets refer to reduction; • Estimate.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 5. PLATINUM CONSUMPTION BY APPLICATION, 1987–89

	1987	1988	1989e
		(000 grams)	
Western world			
Auto catalyst (net)	35 457	36 857	39 656
Chemical	6 065	4 976	5 132
Electrical	5 599	5 754	6 065
Glass	3 732	4 043	4 354
Investment	15 240	19 595	5 132
Jewellery	30 792	36 702	39 345
Petroleum refining	1 711	1 555	1 866
Other	3 732	3 732	3 732
Total	102 329	112 593	105 284
Japan			
Auto catalyst (net)	9 175	9 486	10 108
Chemical	467	467	467
Electrical	1 400	1 400	1 400
Glass	1 400	1 400	1 400
Investment	10 420	12 908	1 866
Jewellery	27 993	32 969	34 835
Petroleum refining	–	–	–
Other	467	467	467
Total	51 320	59 096	50 542
North America			
Auto catalyst (net)	18 351	17 262	17 884
Chemical	1 711	1 711	1 711
Electrical	2 022	2 022	2 333
Glass	778	778	933
Investment	2 644	2 644	1 866
Jewellery	467	467	622
Petroleum refining	467	467	1 089
Other	1 555	1 555	1 555
Total	27 993	26 904	27 993
Rest of western world including Europe			
Auto catalyst (net)	7 931	9 486	11 664
Chemical	3 888	2 799	2 955
Electrical	2 177	2 333	2 333
Glass	1 555	1 866	2 022
Investment	2 177	4 043	1 400
Jewellery	2 333	3 266	3 888
Petroleum refining	1 244	1 089	778
Other	1 711	1 711	1 711
Total	23 016	26 593	26 749

Source: Johnson Matthey Public Limited Company.
– Nil or not separately available; e Estimate.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 6. PALLADIUM CONSUMPTION BY APPLICATION, 1987-89

	1987	1988	1989e
		(000 grams)	
Western world			
Auto catalysts	6 843	5 754	6 065
Dental	29 703	30 947	30 947
Electrical	48 987	53 031	53 031
Jewellery	5 132	5 599	5 754
Other	8 398	8 087	9 020
Total	99 063	103 417	104 817
Japan			
Auto catalysts	2 488	2 177	2 177
Dental	9 020	9 331	9 642
Electrical	28 615	31 725	30 481
Jewellery	2 488	3 266	3 421
Other	1 866	1 244	1 400
Total	44 477	47 743	47 121
North America			
Auto catalysts	3 732	3 266	3 577
Dental	12 130	12 130	12 286
Electrical	12 441	12 597	12 752
Jewellery	311	311	311
Other	3 577	3 421	4 199
Total	32 191	31 725	33 125
Rest of western world including Europe			
Auto catalysts	622	311	311
Dental	8 553	9 486	9 020
Electrical	7 931	8 709	9 797
Jewellery	2 333	2 022	2 022
Other	2 955	3 421	3 421
Total	22 394	23 949	24 571

Source: Johnson Matthey Public Limited Company.
– Nil; e Estimate.
Note: Data converted from ounces; totals may not add due to rounding.

TABLE 7. AVERAGE PRICES FOR PLATINUM AND PALLADIUM

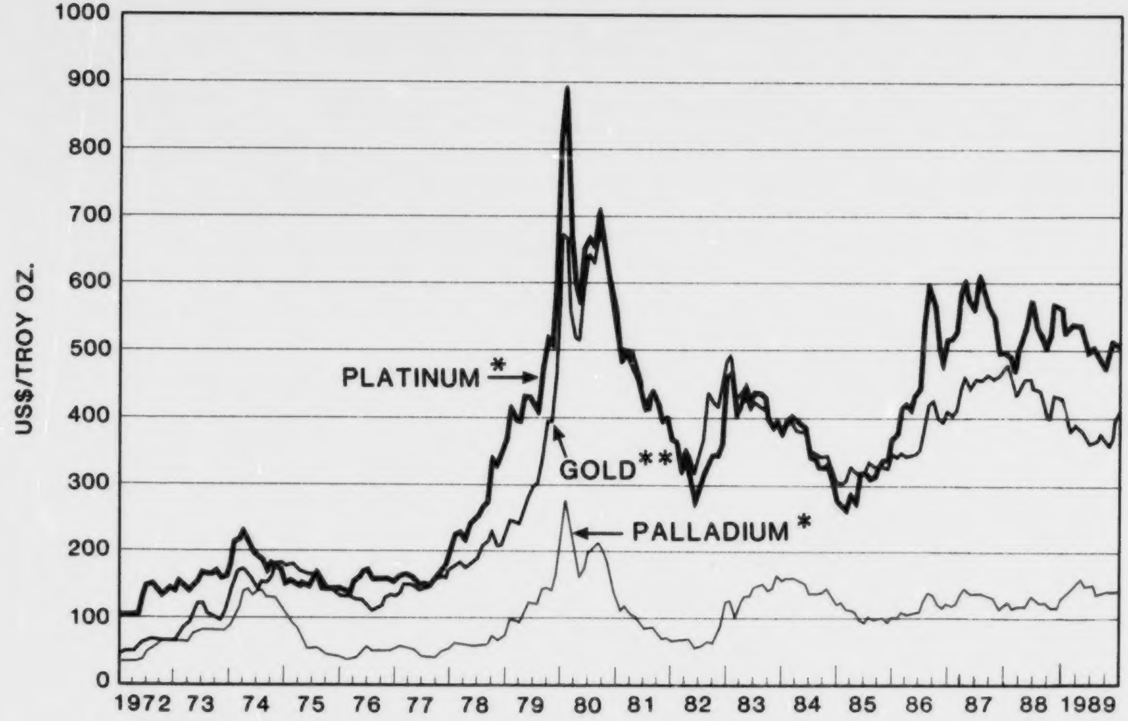
		Platinum		Palladium	
		NY Dealer	London	NY Dealer	London
		(US$ oz.)			
1989	December	501.76	506.36	136.98	138.28
	November	504.19	510.19	138.14	138.99
	October	483.10	485.79	136.98	137.19
	September	476.45	477.49	136.75	137.82
	August	482.96	484.70	133.61	134.74
	July	500.00	501.91	149.95	150.68
	June	494.18	497.36	152.46	153.00
	May	514.96	516.76	152.36	154.11
	April	538.00	537.69	166.25	154.11
	March	534.30	537.98	145.07	146.68
	February	529.90	532.08	141.05	141.49
	January	527.50	527.34	134.95	134.95
1988	December	567.38	569.82	131.14	131.95
	November	566.50	575.80	125.48	126.28
	October	522.10	526.37	120.68	121.86
	September	506.24	512.29	119.62	120.57
	August	529.13	532.75	122.96	123.71
	July	543.25	548.64	124.45	125.89
	June	576.36	579.63	127.46	128.03
	May	544.52	548.94	122.10	123.41
	April	523.33	526.56	121.50	123.00
	March	491.17	496.39	121.44	122.17
	February	451.85	458.51	118.90	119.72
	January	491.58	493.63	123.66	124.49
1987	December	499.50	500.65	120.59	120.30
	November	494.21	500.30	111.21	113.78
	October	564.48	567.67	129.24	131.15
	September	586.33	590.00	136.71	137.24
	August	608.33	610.52	140.00	141.11
	July	568.30	572.32	139.50	141.05
	June	565.27	569.00	136.71	139.02
	May	569.00	606.15	144.70	147.28
	April	584.50	585.59	135.93	137.67
	March	525.23	532.64	122.50	124.17
	February	514.63	517.76	119.50	120.60
	January	515.00	518.86	122.75	123.41
1986	Average	461.59	464.92	115.96	117.00
1985	Average	291.47	. .	105.76	. .
1984	Average	356.82	. .	148.18	. .
1983	Average	423.53	. .	136.16	. .
1982	Average	327.02	. .	66.83	. .
1981	Average	445.99	. .	94.58	. .
1980	Average	677.31	. .	200.78	. .
1979	Average	444.60	. .	119.56	. .
1978	Average	260.77	. .	63.02	. .

Source: Metals Week.

. . Not available.

Figure 1

PRECIOUS METAL PRICES
1972–89



* AVERAGE MONTHLY NEW YORK DEALER PRICE (METALS WEEK)
** AVERAGE MONTHLY LONDON GOLD FIX

Potash

1989

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INTRODUCTION

World production of potash in 1989 is estimated at 30.3 Mt K_2O equivalent, a decrease of 1.3 Mt from 1988. This large decline is mainly attributed to lower production in Canada (-1.0 Mt), the German Democratic Republic (-0.2 Mt), France (-0.3 Mt) and the Federal Republic of Germany (-0.1 Mt); the other producers operated at slightly higher or similar levels to 1988. World demand was slightly lower, resulting in an increase in inventories of between 0.3 to 0.4 Mt.

Production of potash in Canada in 1989 was estimated at only 7.4 Mt, an 11.5% decrease from 1988. Sales, however, were even lower, resulting in a producer stock increase to about 1.6 Mt from 1.36 Mt at the beginning of the year. Canadian exports outside of North America, referred to as "offshore sales," declined to about 2.92 Mt in 1989 from a record 3.78 Mt in 1988. There was a substantial decline in exports to the large markets of China and Brazil.

In 1989, the world potash potential oversupply was still prevailing and overall capacity utilization was about 82%, principally because Canadian mines operated at a very low level of 64%, while all other world producers except France and West Germany continued to operate at near optimum levels of capacity.

In the United States, the increase in potash fertilizer consumption in 1989 was much lower than expected at the beginning of the year. Total planted acreage increased from 319 million acres in 1988 to 331 million acres in 1989 (United States Department of Agriculture - includes "all hay"). However, farmers substantially reduced rates of application as a result of carry-over nutrients in the soil following the drought of 1988.

New Mexico producers formed an export association, New-Potex Ltd., which, like Canpotex Limited, will sell potassium chloride on the "offshore markets." Mississippi Chemical Corporation, Eddy Potash Co., New Mexico Potash Corp., International Minerals & Chemical Corporation (IMC), and the AMAX Chemical Corporation are participating. New-Potex Ltd. is expected to market between 450 000 t and 550 000 t of product annually, mainly to Latin America.

The average unit value of potash shipped was C$134.60/t K_2O (f.o.b. mines) in 1989 compared to $143.20/t in 1988 and $97.15/t in 1987. For 1988, there is a substantial upward revision from only $131.19/t reported as a preliminary figure last year.

The average unit value of potash exported, calculated by Statistics Canada, on the basis of port of exist (e.g. Vancouver or Saint John) or border crossing to the United States, was $184.09/t K_2O in 1989 (based on nine months of exports) compared to $181.73/t in 1988.

The Canadian potash industry reported a net profit of $208 million ($241 million before interest) in 1988 compared to a loss of $22 million (a gain of $49 million before interest) in 1987. Profits in 1989 are expected to be only slightly below those of 1988.

CANADIAN DEVELOPMENTS

Saskatchewan

Saskatchewan produced about 87% of Canadian potash in 1989. The industry employed 3393 persons in 1989 compared to 3370 in 1988.

On July 6, 1989, Saskatchewan's Minister of Energy and Mines announced that a new legislated potash tax system will be in effect January 1, 1990. This system will replace the Potash Resource Payment Agreements (PRPA) which were in force since 1979. Under the new provincial tax system, potash companies will make a base payment of $11/t K_2O of product sold, plus a graduated profit tax, varying from 15 to 50%. Crown royalties and freehold royalties are deductible against the base payment. The base payment will be recognized as a credit towards profit taxes payable; it can be carried forward for five years. Each year the base payment rate and profit tax rates will be adjusted to account for the effects of inflation. Tax credits for R&D totalling up to $5 million per year for the industry as a whole will be continued. The Minister stated that "this new tax system has a number of clear advantages over the old system that will provide a stable fiscal environment encouraging growth and stability in the industry." In 1990, the province expects to collect $148 million (the estimate for 1989 is $120 million).

For periods varying from five to seven weeks in the summer and fall of 1989, all conventional mines in Saskatchewan were closed for maintenance, vacation and limited lay-offs for inventory control. Most mines were also closed for a short period at year-end.

At the end of 1989, Canadian-installed potash production capacity was 10 390 000 t K_2O in Saskatchewan and 1 160 000 t K_2O in New Brunswick, for a total of 11 550 000 t K_2O (19 250 000 KCl). The largest share of Canadian capacity, 45.3%, is held by Potash Corporation of Saskatchewan Inc. (PCS Inc.) followed by International Minerals & Chemical Corporation (IMC) with 15.1%, the largest private potash producer in the western world. Capacity lost to flooding in 1987 is being partially replaced by solution extraction.

The Potash Corporation of Saskatchewan (PCS), which had a profit of $106.1 million in 1988, continued to operate very efficiently and is expected to show a profit of around $85 million in 1989, despite the fact that the volume of sales declined below earlier expectations and inventories rose to above desired levels.

The Saskatchewan legislature passed a bill to privatize PCS on August 14, 1989. The new corporation was capitalized at 35 million common shares. In November, 12 680 000 shares were sold to the public at the issue price of C$18.00 per share. In addition, 90 000 shares were issued to employees. The government also made available to Saskatchewan residents a $200 million, convertible bond issue bearing an interest of 10.75%/year. The three-year bonds are convertible to common shares at the original issue price of $18 per share. In an unusual move, the government transferred to the bondholders the immediate right to vote the convertible amount of shares, a total of 11 111 111 shares. Thus, by year-end the government retained only a 31.7% ownership in PCS. The privatization legislation placed restrictions on the ownership and voting of common shares. These include a restriction against any person or group holding more than 5% of the common shares, a restriction against non-residents of Canada and their associates collectively holding more than 45% of the common shares and a provision limiting, on a prorated basis, the voting rights of common shares held by non-residents of Canada and their associates to 25% of the total vote cast on any resolution. The head office of the operating company, PCS Inc., must remain in Saskatchewan.

PCS controls the right to 575 000 acres in Saskatchewan, on which it estimates recoverable reserves to be approximately 4.3 billion t at an average grade of 22.9% K_2O. The total yield of such ore is estimated at 1.4 billion t of product. Ore accessible from current shafts will permit production for about 100 years. The company controls 8.6 Mt of annual product (KCl) capacity which, at an average K_2O content of 60.9%, is equivalent to 5 235 000 t K_2O. In 1989, production declined to approximately 4 350 000 t of potash (KCl) compared to 5 089 000 t in 1988. The low level of production indicates that overall capacity utilization was only 51%. However, the old Lanigan plant and a large part of the Cory mine were idle in 1988, a situation which temporarily removed about 2.2 Mt (KCl) of production capacity and allowed the remaining units to operate at an average of 68% of usable PCS's capacity in 1989. Total PCS employment at the end of August 1989 was 1268 persons of which 455 were salaried and 813 were hourly. By the end of the year, employment was approximately 1260.

The PCS Rocanville operation is the company's most efficient and productive mine. Working on a four-shift basis, the mine operated consistently at above 95% of its nominal capacity in 1989, excluding the seven-week summer shutdown (four weeks for maintenance and vacation and three weeks for inventory correction), and two weeks in December (maintenance time). The shutdown (lay-off basis) will continue to January 7, 1990. Employment at year-end was 353 (payroll 360). Full automation and guidance on its four-rotor machines are being introduced at Rocanville. This development will allow a better control on dilution and, consequently, will increase efficiency and the grade of ore mined.

Lanigan, the new mill in operation since 1987, is performing well (capacity over 2 Mt KCl). It incorporates electronic processing and monitoring equipment. The old mill was kept idle, but the compaction section can be operated whenever necessary. Mining at Lanigan differs from the other mines because a thicker but lower grade interval of 5.2 m (17 ft.) is mined, compared to 2.5 to 3.3 m in other conventional mines. Employment at the end of 1989 was 314 (payroll 330). The mine had its seven-week summer shutdown followed by one week in December and three weeks in January 1990. Lanigan operates on a three-shift basis (24 hours per day, 10 days out of 14 also known as the 10/4 schedule).

PCS Inc. is the operator of the Allan mine which is 40% owned by its co-tenant, Saskterra Fertilizers Ltd. In 1989, Saskterra was allocated slightly in excess of 50% of production since the company markets its own product. The mine was shut down for seven weeks in the summer and two weeks in December, which was followed by an indefinite lay-off that may last to the end of January 1990. Employment at year-end was 319 persons (payroll 330) on a 10/4 schedule.

The Cory mine operated on a continuous basis throughout the year except for a four-week summer shutdown. Since the partial closure in mid-1988, this operation produces only white soluble and industrial grade products (over 200 000 t/y). Employment at year-end was 109 persons (payroll 112). PCS's 10 t/d industrial grade potassium sulphate plant on Big Quill Lake continued operations throughout the year.

The Esterhazy Division of PCS Inc., was assigned less product from International Minerals & Chemical Corporation (Canada) Limited (IMCC), the operator of the K2 mine, than the year before. Water problems are continuing. The PCS share of costs for remedial efforts was $4.6 million for the first six months of 1989. Esterhazy has two PCS employees.

IMCC which is wholly-owned by IMC Fertilizer Group, Inc., operates two mines near Esterhazy, Saskatchewan, K1 and K2, which are connected underground. In 1989, IMCC produced almost 3.1 Mt KCl of which 22% was on PCS's account. Employment at the Esterhazy operations was approximately 815 in 1989 compared to 850 at the end of 1988. Currently, there are an additional 130 employed on water-related problems. The mines were subject to several inventory control closures: five weeks in June and August and an additional cumulative total of 5 1/2 weeks during the September to December interval. Starting November 18, the work schedule at the K2 mine was changed to the 10/4 schedule.

The K2 mine is still experiencing water problems which started in December 1985. Chemical grouting, introduced in 1987, is ongoing and is the preferred method of keeping the water inflow at a level of about 1000 gallons per minute. The pressure in the overlying water-bearing formation is kept between 80% and 85% of normal formation pressures. In addition, an area about half of one square kilometre is being backfilled through surface bore holes with the objective of stabilizing ground conditions. Most of the water stored in the mine was pumped out and injected into deep wells. Litigation is still in progress over the insurance payments for the water inflow. Meanwhile, the present situation adds to the exploitation costs of potash at the IMCC mines.

IMCC is conducting some exploration drilling for potash in the areas east and west of the mines. A test shaft pilot hole will be drilled in the spring of 1990 with the objective of keeping the company's options open on the eventual sinking of new shafts.

Potash Company of America (PCA), a division of Rio Algom Limited, which lost its Patience Lake conventional potash mine to flooding in 1987, continued to make progress in solution recovery. The conversion to a solution mine required a capital investment of about $24 million. The potash extraction scheme required the drilling of intake/outlet wells to pump out potash-rich brine. The surface precipitation takes place in ponds, following the principle of natural preferential precipitation of KCl from the hot saturated brines as these are cooled in a winter environment (October to April). The ponds are in series and cover an area of about 130 acres. The recovery of brines from the mine is carried out through nine recovery wells that are associated with eight injection wells. A monitor well has also been put in place. The potash "harvested" from the ponds is fairly high-grade and only limited leaching is required to upgrade it to a premium 62% K_2O product. In 1989, some production was obtained from the early winter program and more commercial production was obtained from late September to December, for a total of about 135 000 t KCl. It will take until the end of this winter's campaign to determine the full potential of the operation and the optimum level of capacity which initially was targeted at around 700 000 t/y KCl. Employment at the end of 1989 was 126.

Central Canada Potash (CCP), a division of Noranda Minerals Inc., produced about 1 032 000 t of potash KCl in 1989 compared to 1 100 000 t in 1988. The company had an inventory control summer shutdown of nine weeks and a temporary closure of three weeks starting December 24; the remainder of the time CCP operated its mines on a continuous basis. Employment at the end of 1989 was 380 (no change from the previous year).

Cominco Ltd. produced 963 000 t of potash (KCl) in 1989 in its Vanscoy mine, compared to 1 098 000 t in 1988. The company closed its mine for six weeks in the summer and one week in December. The mine is run on a seven-day per week schedule. Employment at year-end was 330 compared to 317 the previous year.

Kalium Canada, Ltd. also known as Kalium Chemicals, operates a large solution mine at Belle-Plaine, west of Regina. During 1989, the company produced about 1.0 Mt K_2O, or 10% below last year's level. An expansion program to a total capacity of 1.245 Mt K_2O was completed in 1987 but, because of market constraints, Kalium has not yet utilized its full potential. The plant has two lines of crystallizers. For a total period of just over three months in 1989 the company ran only one line. Employment at the end of the year was 322. Kalium disposed of some of its waste salt in underground cavities on an experimental basis. The company feels that it will be technically possible to dispose 100% of its waste underground in the future.

Saskterra Fertilizers Ltd., a wholly-owned subsidiary of Canterra Energy Ltd. which is controlled by Husky Oil Ltd., owns 40% of the Allan potash mine (60% PCS). In 1989, the company elected to market more than its proportional share of production mainly through the trading company, ICEC. Husky Oil Ltd. intends to sell Saskterra if an attractive offer is made.

New Brunswick

The Potash Company of America (PCA), which has a mine in Saskatchewan, also operates the Penobsquis mine situated 5 km east of Sussex, New Brunswick. The orebody at this mine is steeply dipping, requiring mechanized cut and fill mining. The mine operated throughout the year without problems, near optimum capacity utilization. It has a closed system, i.e. all waste salt and waste brines have to be returned underground. Production at the Penobsquis mine was just over 600 000 t KCl in 1989, very near optimum capacity levels. The company had about 350 employees at year-end. The mine operated on a seven-day per week basis with a two-week maintenance shutdown in August.

PCA (N.B.) exports practically all of its potash production through a new potash terminal located at Saint John, which it operates on behalf of the two New Brunswick producers. The terminal has a permanent employment of eight, but supports a total labour force of about 20 on an annual basis.

The Denison-Potacan Potash Company (DPPC) produced just over 980 000 t of potash (KCl) in 1989 at the Cloverhill mine located 20 km southwest of Sussex, New Brunswick. The mine experienced some problems with roof failure that resulted in fatalities and a loss of production. Measures to optimize safety are in place. The orebody is complex, requiring both drill and blast methods and extraction with continuous mining machines, which is carried out in a proportion of about 55 to 45. Waste salt has been returned to the mine since 1987, while excess brine is dispatched by pipeline to the Bay of Fundy. Progress has been steady and in 1989 about 40% of its waste was returned underground. This proportion should rise to about 70% in 1990. Employment at the end of 1989 was 593. The mine was shut down for maintenance for two weeks in the summer and operated at reduced production rates in some months thereafter.

Manitoba

The Manitoba Potash Corporation (MPC), jointly held by Canamax Resources Inc. (51%) and the Manitoba government (49%), continued unsuccessfully to look for major partners for the development of a potash deposit near Russell. In mid-November, the Manitoba Minister of Mines said at a meeting of a local Chamber of Commerce that he does not expect a development decision before the 1992-94 period for a target production in the 1997 to 1999 interval ("a window of opportunity" if the market conditions continue to improve along current expectations).

INTERNATIONAL DEVELOPMENTS

There was a substantial decline in world potash demand in 1989 centred in the three crucial economies: the United States, the U.S.S.R. and China. Several smaller and fast-growing importers also curtailed their purchases resulting in an overall decline in demand in excess of 5%. While some of the larger international traders held on to price levels negotiated at the beginning of the year, prices (at best) were held steady for part of the year, with much pressure developing towards the end of 1989.

In response to these conditions, world production declined by some 1.3 million t K_2O. Besides the very large decrease in Canada, which again acted as the chief residual supplier, there were some voluntary adjustments particularly in France and the Federal Republic of Germany, and an involuntary reduction in the Democratic Republic of Germany. Producers in the United States, however, took full advantage of the firm "post-dumping charge" market conditions and increased production to a five-year record level. There is no evidence of further significant increases in production in the U.S.S.R. but, because of a fall in domestic deliveries, a significant quantity of product from this country was dumped in many markets without much regard to price or firm delivery schedules.

The Taquari mine in Brazil continued to struggle with production problems, achieving an output of 98 000 t K_2O in 1989. The company also commercialized about 80 000 t of common salt. The company's objective is to increase production towards initial capacity targets and, to this end, four mining machines were ordered for delivery by mid-1990. There remains some uncertainty of whether or not the mine will be able to continue operation under severe negative cash-flow conditions, unless efficiency improves rapidly.

The development of 120 000 t/y K_2O new capacity on the Qarham dry lake in China was reported to have reached the initial production stage in 1989. It is too early to establish with certainty the future production levels; this is attested to by estimates for 1989 production which ranged from 30 000 to 100 000 t. The development of this facility incurred very high capital costs. Demand for potash in China, as measured by import levels, declined by almost one third in 1989.

In Chile, Sociedad Mineral Salar de Atacama Ltda (MINSAL Ltda) completed the feasibility studies on potash production from the Atacama brines and a development decision is expected to be made in the first quarter of 1990. This operation will eventually produce between 300 000 t and 400 000 t K_2O.

France's production in 1989 declined by 18% principally because of the need to respond to new market conditions of oversupply. Limited strikes during 1989 also contributed to the situation. The effluence of salt to the Rhine River declined to comply with recent environmental regulations.

In the Federal Republic of Germany production of potash registered a small decrease of about 100 000 t principally as a result of longer-than-normal closures at some mines in the summer and over the year-end holiday season. These closures amounted in total to four to five weeks, depending on the mine and its product mix.

The Democratic Republic of Germany experienced a significant fall in production as a result of a major rock fall in the Merkers mine in March 1989. An area of some 12 km^2 was affected by the collapse. There were accusations that a contributing factor was deep-well brine injection across the border in the Federal Republic of Germany, but independent authorities determined that the likely cause was an excessive system of exploitation that left small pillars that were bound to fail over time. This catastrophic experience will continue to have an effect on the future mining practices in the Democratic Republic of Germany. Towards the end of the year, the Merkers and Dorndorf mines were connected by an underground tunnel and a conveyor system, which will allow Kombinat Kali to use the partially idle Merkers refinery for some excess ore from the Dorndorf. Generally, it is expected that potash capacity in the Democratic Republic of Germany will now remain at a level not much in excess of 3.3 Mt K_2O and, as a result of a more rational approach to mining, may even decline in the future.

In Israel, Dead Sea Works Ltd. (DSW) increased production slightly over the last year despite a two-week strike in April, the first over a period of ten years. Work to add a small increment to the existing capacity is in progress. Construction of the SOP (sulphate of potash) plant was well on schedule and pilot production tests will be conducted during 1990.

Italian production increased to 152 000 t K_2O in 1989. About 98% of the output is in the form of sulphate of potash.

In Jordan, the Arab Potash Co. Ltd. (APC) enjoyed a normal year of operation, producing 1.32 Mt of KCl while sales were 1.26 Mt. Deepening of the intake channel to the Dead Sea was completed. Pilot plant experiments for cold leach crystallization were undertaken and a fullfledged feasibility study is expected to be completed by the end of 1990. It may lead to a further expansion of capacity by 240 000 t/y.

In Spain, production in 1989 declined slightly to 742 000 t K_2O. The Navarra mine continued to perform above expectations, while the Cardona mine experienced a difficult year.

In Thailand, limited work was carried out on the existing potash concessions. Two Canadian companies, Placer Dome Inc. and The Crew Group of Vancouver, are finalizing negotiations for a partnership on two potash concessions in the Sakon Nakhon (east) area (3500 km^2) and the Udon Thani area (2333 km^2), respectively. Former concession holders have relinquished their rights. The target is secondary and primary sylvinite deposits. At Banmet Narong, near the western extremity of the Khorat Basin, a carnallite deposit has been designated for future development. In November 1989, the Thai government announced that an agreement in principle was obtained at an ASEAN meeting of finance ministers to bring the mine into operation pending a number of steps which will include a new feasibility study. A pre-feasibility study completed to date was positive, but may not have been definitive enough to guarantee the economic viability of this development. Economic mining of low grade carnallite deposits faces a daunting challenge, since it has never been accomplished successfully anywhere in the world.

In the United Kingdom, Cleveland Potash Ltd. (CPL) completed a routine year, producing approximately 460 000 t K_2O. A new Jeffrey heliminer bought in 1988 is now performing satisfactorily after some initial problems. The company is expected to increase output slightly in 1990.

In the United States, total nominal potash capacity was raised to 1 675 000 t K_2O and capacity is likely to rise to about 1.76 Mt in 1990. However, the future of two mines in the Carlsbad area is uncertain. One may have to discontinue operations momentarily if the potash price remains at current depressed levels, while the other has reserves for only a few years. Nevertheless, capacity lost at Carlsbad is likely to be replaced by a solution-type mine in Michigan.

In 1989, U.S. production reached a high of 1 537 000 t K_2O, a substantial improvement from the low of 1 200 000 t established in 1986. Great Salt Lake Minerals & Chemicals Corporation (GSL), Utah resumed operations after a hiatus of five years. The production of sulphate will rise slowly to full capacity by 1992. The plant of Reilly Wendover Chemical Inc. operated at near optimum capacity while the third Utah producer, Texasgulf Inc. at Moab, produced a little below its current capacity of 60 000 t/y K_2O. Potash production at this site is expected to decline very slowly over the next ten years. Plans for solution mining for the area proposed two years ago by local promoters have been shelved.

In the Carlsbad area, Eddy Potash Co. continued to operate satisfactorily, compacting some of their product at the AMAX mill at the beginning of the year. AMAX Chemical Corporation decided late in 1988 to postpone closure by a start-up of production on a very low-grade, 1.2 m thick bed of potash which normally would have been uneconomic. The company constructed several special-type "PCA miners" and, by the end of 1989, had 11 in place. Under prices prevailing at the beginning of 1990, this mine is probably not viable and there is a possibility that it could be sold and amalgamated with Eddy Potash, which would allow the extraction of some additional ore near the joint boundary and the use of its compaction and storage facilities by Eddy Potash. Products from the Eddy Potash Co. and the New Mexico Potash Corp.'s Hobbs mine (high grade production plus 62.2% K_2O) are sold through one marketing agency since both mines are controlled by the same company, Cedar Chemical Inc.

Mississippi Chemical Corporation re-started mining potash in 1989 and produced near-capacity levels of about 160 000 t/y K_2O. The company compacts and stores product at the nearby surface plant of National Potash.

International Minerals & Chemical Corporation (IMC), one of the oldest and most versatile Carlsbad producers, operated continuously throughout 1989.

Western Ag-Minerals Co. produces potassium-magnesium sulphate, mainly for the citrus industry. The Canadian shareholders, Rayrock Yellowknife Resources Inc., increased their ownership from 35% to 100% in January 1990.

Kalium Chemicals holds a deep-seated potash deposit near Hersey, Michigan. The company completed a small pilot plant of about 40 000 t (product) capacity. The plant is running well. Its operation will demonstrate the viability of a full-scale mine, which is likely to be put on-stream by the mid-1990s.

The U.S.S.R. is the world's leading producer of potash and the second leading exporter after Canada. Exports to the COMECON countries (East Europe, Cuba, Vietnam and North Korea) average about 2.1 Mt/y K_2O and are expected to remain at this level for the next few years. By contrast, exports to market-economy countries increased from 1 368 000 t K_2O in 1988 to about 1.6 Mt in 1989, and may continue to rise to near the 2.0 Mt level by the mid-1990s. The main reason for this is a much reduced domestic consumption. While most of trade was still carried out by SOJUZAGROCHIMEXPORT, some direct sales by producers were a factor that had a depressing effect on prices, principally in Europe. Transportation logistics were a limiting factor on trade.

PRICES

Potash prices remained fairly stable throughout most of the year. The f.o.b. Vancouver price that was US$90-95/t KCl at the beginning of the year, rose to just over $100/t during the first half of the year and declined to a level that prevailed at the start of the year. Prices in the U.S. market remained at a level equivalent to about US$90/t f.o.b. mine (granular) for the first half of 1989. The expected spring price increases did not materialize and the price fell by some $3/t during the third quarter. In mid-December, a major Canadian producer announced a one-week "market adjustment" sale under which prices were discounted by about US$20/t of product. Subsequently, the company issued a new list (January 1, 1990) under which the price of granular was set at US$80/t, combined with January 1 to 15 and January 16 to the end of February quick delivery discounts of $9.00/t and $4.00/t respectively. The last price level still continues to comply with the five-year suspension agreement with the United States Administration that resulted from the settlement of the dumping case on January 8, 1988, and further declines are not expected. Offshore potash prices were only slightly affected by U.S. markets as these would have to increase by a further US$5 to $10/t before an equilibrium is achieved. The higher U.S. price continued to attract additional sales from non-traditional suppliers.

OUTLOOK

At the beginning of 1989 agronomists expected a 9% to 12% increase in acreage in the United States and a commensurate rise in potash consumption. It did not happen. Planted acreage rose by only 3.7%, and potash application per acre was very low, as farmers counted on a high residual potash level in the soil following the 1988 drought. These factors, combined locally with inclement weather in the spring and fall, contributed to a lower consumption of potash than predicted. The prognosis for 1990 is much more cautious. Planted acreage is estimated to increase by 1% to 2%, an increase that will be attributed mainly to wheat and corn. Overall potash consumption is estimated to increase by 4% to 6%, mainly on account of higher application rates on the corn acreage.

China's demand for potash was less than 1.0 Mt K_2O in 1989 and much uncertainty remains regarding Chinese intentions in 1990. Canadian-sponsored agronomic programs in support of balanced NPK fertilization are continuing to bear fruit. The main obstacle for increased imports of potash will be the availability of hard currency in the short term, while logistics of transport and distribution pose added problems on a long-term basis.

The U.S.S.R. increased substantially its potash exports to western countries for the second consecutive year at the expense of domestic deliveries. Subsidies to fertilizers and other farm inputs are being phased out and the responsibility for fertilization practice shifted to local agrarian groups. The resulting decline in consumption may last for a few years. Meanwhile, potash-producing enterprises and export groups will be allowed to keep a better part of hard currency gained from export for their own use, which is a very strong incentive for export maximization. In 1989, Soviet exports outside COMECON were estimated at about 1.6 to 1.7 Mt K_2O (or 1.8 Mt outside of Eastern Europe). Soviet exports may continue to increase to about 2.0 Mt before they stabilize.

There should be a slight improvement in demand in 1990 in Latin America, particularly after the rather disappointing 1989 level of demand in Brazil.

In general, the annual growth rate in world potash demand for the 1990s should range between 1.7% and 2.0%. Nevertheless, it is estimated that it will take a few more years, perhaps up to the 1998-2000 period, before new capacity is required in Canada, particularly because some 1.6 Mt K_2O of additional capacity is likely to be added between 1990 and 2000 outside of Canada. These expected additions will likely be economically viable; there is always a possibility that other developments may be undertaken in some countries to satisfy political objectives regardless of economic imperatives.

Since it takes between five and eight years to bring new mines into production, some companies are already examining mining opportunities for the late 1990s. Modest expansions to existing mines can be instituted in a shorter time-frame of about three years, so that such decisions may safely be deferred. While opportunities will emerge, the potash mining industry must be vigilant against crowding too many development projects to its own detriment, into a short time-frame.

Note *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, POTASH PRODUCTION, SHIPMENTS AND TRADE, 1988 AND 1989

		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production, Potassium Chloride					
Gross weight		13 617 344	. .	12 162 295	
K_2O equivalent		8 310 586	. .	7 422 500	. .
Shipments					
K_2O equivalent		8 154 428	1 167 747	7 036 529	946 960
Imports, Fertilizer Potash				**(Jan.-Sept.)**	
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	3 519	378	1 913	453
	West Germany	209	18	376	43
	United Kingdom	-	-	2	...
	Sweden	37	16	-	-
	Total	3 765	413	2 291	497
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	7 471	2 697	7 904	2 423
	Italy	275	79	69	42
	West Germany	61	13	1	2
	Netherlands	-	-	2	1
	United Kingdom	-	-	...	...
	France	2 000	500	-	-
	Total	9 807	3 290	7 976	2 469
3104.90.00.10	Magnesium potassium sulphate				
	United States	43 970	5 888	16 460	2 682
	West Germany	10	3	45	8
	Total	43 980	5 892	16 505	2 690
3104.90.00.90	Other, potassic fertilizer				
	United States	1 831	880	1 500	715
	Other countries	46	61	111	59
	Total	1 877	941	1 611	774
Potash Chemicals					
2815.20	Potassium hydroxide (caustic potash)	6 293	3 344	8 386	3 554
2834.21	Potassium nitrate	4 771	2 397	4 380	2 176
2835.24	Potassium phosphates	2 400	2 661	1 900	2 099
2836.40	Potassium carbonates	1 662	1 108	1 074	720
2839.20	Potassium silicates	808	596	601	471
	Total potassium chemicals	15 934	10 106	16 341	9 020
Exports, Fertilizer Potash				**(Full year)**	
3104.20	Potassium chloride, in packages weighing more than 10 kg				
	United States	6 157 980	679 559	5 842 605	615 165
	People's Republic of China	1 465 253	150 986	1 095 624	123 029
	Brazil	666 440	73 599	555 080	63 091

TABLE 1. (cont'd)

		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
	Japan	657 570	77 271	634 133	75 844
	India	396 614	40 171	337 191	34 107
	South Korea	505 705	55 605	425 936	50 095
	Malaysia	376 120	41 336	309 721	36 933
	Australia	257 174	28 473	292 808	34 749
	France	123 634	13 687	214 952	25 032
	Indonesia	287 933	30 729	128 603	15 042
	New Zealand	34 444	3 821	114 453	13 650
	Taiwan	185 201	20 392	105 167	12 323
	Chile	174 564	18 993	66 000	7 803
	Belgium	102 466	11 441	71 130	7 613
	Denmark	88 659	8 408	96 037	10 590
	Bangladesh	83 062	8 655	62 929	6 904
	Philippines	92 379	9 923	90 274	9 660
	Netherlands	26 976	2 865	45 871	5 200
	Singapore	219 132	23 235	44 805	5 024
	Nigeria	27 996	2 952	40 000	3 196
	United Kingdom	124 755	14 056	24 700	3 047
	Mexico	143 451	14 823	21 971	2 107
	South Africa	13 524	1 509	22 903	2 469
	Venezuela	83 624	8 523	30 957	2 806
	Colombia	12 000	1 291	54 126	4 610
	Jamaica	13 528	1 721	13 110	2 148
	Norway	30 077	3 074	16 086	1 691
	Italy	54 864	6 093	37 209	4 284
	Peru	7 350	730	10 734	1 327
	Guatemala	15 750	1 568	21 943	1 480
	Other countries	123 765	13 164	54 694	6 331
	Total	12 551 990	1 368 653	10 905 962	1 189 577
3104.30	Potassium sulphate, in packages weighing more than 10 kg				
	United States	1 857	397	129	21
	Philippines	5 444	1 262	-	-
	Total	7 301	1 660	129	21

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; .. Not available; ... Amount too small to be expressed; - Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, POTASH PRODUCTION AND TRADE, FERTILIZER YEARS-ENDED JUNE 30, 1966, 1971, AND 1976-89

	Production[2]	Imports[1,2]	Exports[2]
	(tonnes K_2O equivalent)		
1966	1 748 910	31 318	1 520 599
1971	3 104 782	26 317	3 011 113
1976	4 833 296	16 445	4 314 150
1977	4 803 015	24 289	4 175 473
1978	6 206 542	26 095	5 828 548
1979	6 386 617	21 819	6 256 216
1980	7 062 996	20 620	6 432 124
1981	7 336 973	35 135	6 933 162
1982	6 042 623	25 437	5 400 662
1983	5 378 842	21 846	4 864 219
1984	7 155 599	17 934	6 730 733
1985	7 283 509	17 396	6 784 178
1986	6 519 777	12 837	6 479 678
1987	7 031 586	12 122	7 100 135
1988	7 839 625	14 486	7 315 318
1989	8 088 748	13 748	7 075 122

Sources: Potash and Phosphate Institute; Canadian Fertilizer Institute.

[1] Includes potassium chloride, potassium sulphate, except that contained in mixed fertilizers. [2] Change of data source. Prior to 1978 figures were obtained from Statistics Canada.

TABLE 3. CANADA, POTASH PRODUCTION AND SALES IN 1988 AND BY QUARTERS, 1989

		1989			
	Total (1988)	1st quarter	2nd quarter	3rd quarter	4th quarter
			(000 tonnes K_2O)		
Production	8 327.3	2 111.8	2 110.6	1 272.7	1 865.1
Sales					
North America	4 313.8	964.0	1 132.1	877.5	1 220.0
Offshore	3 792.6	636.8	1 021.9	650.4	614.7
Total	8 106.2	1 600.8	2 154.0	1 527.7	1 834.7
Ending Inventory					
Mine site	488.3	753.7	835.3	757.6	846.6
Offsite	868.1	770.4	988.8	811.5	749.6
Total	1 356.4	1 130.6	1 824.1	1 569.0	1 596.2

Source: Potash and Phosphate Institute.

TABLE 4. CANADA, POTASH SALES BY PRODUCT AND AREA, 1987 AND 1988

		Agricultural					Industrial			Total
		Standard	Coarse	Granular	Soluble	Total	Standard	Soluble	Total	Sales
		(tonnes K_2O equivalent)								
Alberta	1987	223	46	26 735	2 308	29 313	2 450	54	2 505	31 818
	1988	243	114	26 608	1 737	28 703	3 331	432	3 763	32 466
British Columbia	1987	34	66	1 184	54	1 337	-	-	-	1 337
	1988	2 615	399	5 918	59	8 990	-	-	-	8 990
Manitoba	1987	15	4 064	15 633	2 148	21 861	24	-	24	21 885
	1988	-	3 962	18 828	2 178	24 968	7	26	33	24 001
New Brunswick	1987	12	5 982	9 172	87	15 253	-	-	-	15 253
	1988	-	7 348	5 935	389	13 672	-	-	-	13 672
Nova Scotia	1987	-	-	6 408	-	6 408	-	-	-	6 408
	1988	-	-	5 619	268	5 887	-	-	-	5 887
Ontario	1987	153	168 953	64 345	2 132	235 583	10 546	307	10 853	246 436
	1988	5 363	118 369	46 324	2 415	172 471	11 695	298	11 992	184 463
Prince Edward Island	1987	-	-	10 671	-	10 671	-	-	-	10 671
	1988	-	54	10 031	-	10 085	-	-	-	10 085
Quebec	1987	41	21 737	95 560	27	117 364	935	12	947	118 311
	1988	230	20 265	96 265	89	116 850	783	-	783	117 633
Saskatchewan	1987	(70)	3 883	36 082	74	39 969	3 583	3 866	7 449	47 418
	1988	77	223	10 172	250	10 723	5 000	1 637	6 637	17 360
Newfoundland	1987	-	-	-	-	-	-	-	-	-
	1988	-	-	-	-	-	-	-	-	-
Totals	1987	408	204 731	265 790	6 830	477 760	17 538	4 239	21 777	499 537
	1988	8 529	150 735	225 700	7 386	392 350	20 816	2 393	23 209	415 559

Source: Potash and Phosphate Institute.
- Nil; ( ) Brackets indicate negative quantities.

TABLE 5. CANADA, POTASH INVENTORY, PRODUCTION, DOMESTIC SALES AND EXPORT SALES, 1989

			Domestic Sales		Export Sales			
					United States		Offshore	
	Beginning Inventory	Production	Agri-cultural	Non-agri-cultural	Agri-cultural	Non-agri-cultural	Total	Total Sales
				(000 tonnes K_2O)				
January	356.4	764.5	9.7	1.5	401.0	27.4	137.3	576.9
February	1 538.2	645.0	18.1	1.1	200.0	22.6	184.4	426.2
March	1 736.1	702.2	25.7	1.2	203.3	25.7	315.0	570.9
April	1 867.4	751.3	46.2	1.2	444.9	23.4	345.4	861.1
May	1 737.7	760.2	101.1	1.1	363.8	22.0	344.3	832.3
June	1 690.3	599.1	23.0	0.9	123.0	25.7	332.1	504.7
Sub-total		4 222.3	223.8	7.0	1 736.0	146.8	1 658.5	3 772.1
July	1 824.0	340.1	4.7	0.9	165.3	20.5	311.3	502.7
August	1 622.0	302.2	5.7	1.5	355.9	22.3	188.8	574.2
September	1 372.7	630.5	14.2	1.1	255.1	21.3	150.2	441.9
October	1 569.1	652.5	19.5	1.5	282.0	26.4	214.7	544.1
November	1 670.6	669.0	20.0	1.0	237.0	27.0	156.4	441.4
December[1]	1 879.0	543.6	12.8	0.8	564.4	27.6	243.6	849.2
Sub-total		3 137.8	76.9	6.8	1 859.7	145.1	1 265.0	3 353.3
Total 1989		7 360.1	300.7	13.8	3 595.7	291.9	2 923.5	7 125.6
1988		8 327.3	392.4	23.1	3 576.7	256.1	3 782.6	8 030.9
% change 1989/88		-11.6	-23.4	-40.3	+ 0.5	+ 14.0	-22.7	-11.3

Source: Potash and Phosphate Institute.

[1] Inventory at the end of December 1989 was 1 596 213 t.

TABLE 6. WORLD POTASH PRODUCTION

	1983	1984	1985	1986	1987	1988p	1989e
	(000 tonnes K_2O)						
Brazil	-	-	6	11	37	48	98
Canada	5 930	7 749	6 637	6 697	7 267	8 328	7 360
Chile	-	-	-	-	-	5	10
China	25	20	20	20	25	30	50
France	1 539	1 740	1 750	1 610	1 539	1 502	1 195
Germany Dem. Rep.	3 341	3 463	3 465	3 485	3 510	3 510	3 285
Germany, Fed. Rep.	2 419	2 645	2 583	2 162	2 201	2 290	2 185
Israel	929	1 130	1 172	1 240	1 265	1 242	1 271
Italy	133	127	143	109	122	126	152
Jordan	168	291	545	662	722	786	792
Spain	659	677	645	702	740	766	742
U.S.S.R.	9 294	9 776	10 367	10 228	10 889	11 000	11 100
United Kingdom	303	319	337	391	429	452	463
United States	1 429	1 564	1 296	1 202	1 262	1 461	1 580
Total	26 163	29 501	28 960	28 551	30 008	31 546	30 283

Sources: International Fertilizer Industry Association Ltd.; U.S. Bureau of Mines; Energy, Mines and Resources Canada. Production in Canada conforms with the PPI statistics.
p Preliminary; e Estimated; - Nil.

TABLE 7. CANADA POTASH, CURRENT SITUATION AND FORECAST

		Actual						Forecast	
		1984	1985	1986	1987	1988	1989[e]	1990	1991
					(000 tonnes K_2O)				
Capacity		9 320	9 780	10 580	11 020	11 430	11 550	11 800	11 800
Production		7 749	6 636	6 698	7 267	8 328	7 360	7 300	8 000
Capacity Utilization (%)		83	68	63	66	73	64	63	68
Sales:		7 071	6 577	7 023	7 837	8 030	7 100	7 500	8 050
of which:	Domestic	436	434	322	480	420	360	400	450
	United States	4 090	4 215	4 091	4 224	3 830	3 820	3 900	4 000
	Offshore	2 545	1 928	2 610	3 114	3 780	2 920	3 100	3 600
End-year stocks		1 543	1 766	1 537	1 135	1 360	1 600	1 400	1 550
World Production		29 501	28 960	28 551	29 309	31 650	30 300	30 600	31 400
Canada World Production Ratio (%)		26.3	22.9	23.5	24.7	26.3	24.3	23.9	25.5

[e] Estimated.

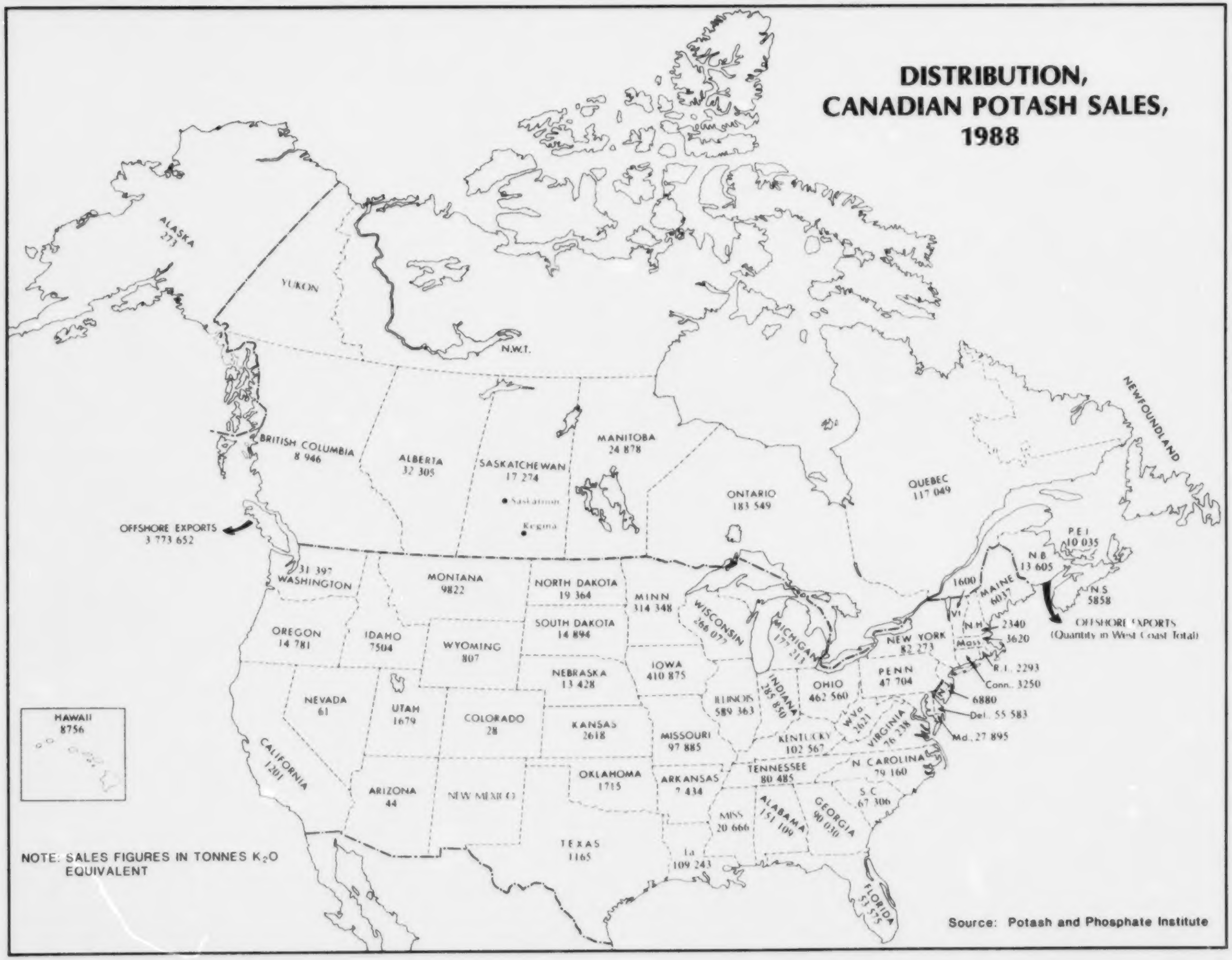
TABLE 8. CANADA, POTASH MINES - CAPACITY PROJECTIONS

	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
						(000 tonnes K_2O equivalent)						
Potash Corporation of Saskatchewan												
- Allan (60%)	575	575	575	575	575	575	575	575	575	575	575	575
- Cory	830	830	830	830	830	830	830	830	830	830	830	830
- Esterhazy (25% of IMC)	580	580	580	580	580	580	580	580	580	580	580	580
- Lanigan	690	690	1 240	1 740	2 090	2 090	2 090	2 090	2 090	2 090	2 090	2 090
- Rocanville	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Sub-total	3 835	3 835	4 385	4 885	5 235	5 235	5 235	5 235	5 235	5 235	5 235	5 235
Central Canada Potash	815	815	815	815	815	815	815	815	815	815	815	815
Cominco Ltd.	655	815	815	815	815	815	815	815	815	815	815	815
International Minerals & Chemical Corporation (75%)	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745	1 745
Kalium Chemicals.	1 055	1 055	1 055	1 245	1 245	1 245	1 245	1 245	1 245	1 245	1 245	1 245
Potash Company of America, Inc.	630	630	630	100	30	150	400	400	400	400	400	400
Saskterra Fertilizers Ltd. (Allan 40%)	385	385	385	385	385	385	385	385	385	385	385	385
Sub-total	5 285	5 445	5 445	5 105	5 035	5 155	5 405	5 405	5 405	5 405	5 405	5 405
Total Saskatchewan	9 120	9 280	9 830	9 990	10 270	10 390	10 640	10 640	10 640	10 640	10 640	10 640
Denison Mines Limited, N.B.	-	200	450	650	780	780	780	780	780	780	780	780
Potash Company of America, Inc.	200	300	300	380	380	380	380	380	380	380	380	380
Total New Brunswick	200	500	750	1 030	1 160	1 160	1 160	1 160	1 160	1 160	1 160	1 160
Canada	9 320	9 780	10 580	11 020	11 430	11 550	11 800	11 800	11 800	11 800	11 800	11 800

Note: Capacity means "rated" capacity; under normal conditions Canadian mines can operate comfortably at about 90% of rated capacity.

- Nil.

DISTRIBUTION, CANADIAN POTASH SALES, 1988


ALASKA 273
YUKON
N.W.T.
BRITISH COLUMBIA 8 946
ALBERTA 32 305
SASKATCHEWAN 17 274
Saskatoon
Regina
MANITOBA 24 878
ONTARIO 183 549
QUEBEC 117 049
NEWFOUNDLAND
P.E.I. 10 035
N.B. 13 605
N.S. 5858
OFFSHORE EXPORTS (Quantity in West Coast Total)
OFFSHORE EXPORTS 3 773 652
31 397 WASHINGTON
OREGON 14 781
CALIFORNIA 1201
NEVADA 61
IDAHO 7504
MONTANA 9822
WYOMING 807
UTAH 1679
COLORADO 28
ARIZONA 44
NEW MEXICO
NORTH DAKOTA 19 364
SOUTH DAKOTA 14 894
NEBRASKA 13 428
KANSAS 2618
OKLAHOMA 1715
TEXAS 1165
MINN 314 348
IOWA 410 875
MISSOURI 97 885
ARKANSAS 7 434
La 109 243
WISCONSIN 266 077
ILLINOIS 589 363
MICHIGAN 177 211
INDIANA 285 850
OHIO 462 560
KENTUCKY 102 567
TENNESSEE 80 485
MISS 20 666
ALABAMA 151 109
GEORGIA 90 030
FLORIDA 53 575
S.C. 67 306
N CAROLINA 79 160
VIRGINIA 76 238
W.Va 2621
PENN 47 704
NEW YORK 82 273
Vt 1600
N.H. 2340
MAINE 6037
Mass 3620
R.I. 2293
Conn. 3250
6880
Del. 55 583
Md. 27 895
HAWAII 8756

NOTE: SALES FIGURES IN TONNES K_2O EQUIVALENT

Source: Potash and Phosphate Institute

Primary Iron and Ferrous Scrap

1989

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PRIMARY IRON

Primary iron is the raw material used to make steel and other iron products such as castings. It includes blast furnace iron, direct reduced iron and, in Canada, electric smelted iron. Recycled ferrous scrap, as a substitute for primary iron, is very important and used in increasingly sophisticated ways for steel production. Approximately 50% of the iron units used to make steel in Canada are sourced from scrap.

Primary iron is produced in Canada by three main processes. The bulk of production is by blast furnaces. Iron produced by electric smelting and by direct reduction are next in importance, with equivalent quantities produced by each process. The foundry industry uses cupolas and electric furnaces for melting scrap and pig iron to produce castings.

CANADIAN EVENTS

Since almost all of the primary iron produced in Canada is used in the production of steel, trends in steel production, and in demand for steel mill products, influence production of primary iron. Therefore, this review will frequently refer to developments in the steel industry.

Blast Furnace Iron

Canadian production of blast furnace iron, in the first nine months of 1989, increased 12.41% to 7.79 Mt, compared to the same period in 1988. This increase was due to high demand for steel. Raw steel production increased 8.2% to 11.74 Mt in the first nine months of 1989.

Primary iron production increased proportionately more than steel production because, on average, more (a higher percentage of) iron was used in each tonne of steel produced. This change may be explained by the following facts:

- The percentage of total steel production made by the electric furnace industry declined for the first time in over 10 years. In the first nine months of 1989, electric steel production was 3.59 Mt, a 1.13% decrease from the 3.63 Mt level of 1988.
- Quantities of own-generated scrap, at integrated steel producers, have been significantly decreased by recent increases in the use of continuous casting equipment. Continuous casters allow up to 10-15% more finished product to be produced from each tonne of molten steel, so that much less in-house scrap is generated.
- The takeover of The Algoma Steel Corporation, Limited by Dofasco Inc. resulted in greater utilization of Algoma's blast furnace capacity.
- Finally, the price of scrap was at high levels throughout most of the year reducing the cost advantage of substituting scrap for molten iron at integrated plants, and reducing the spread between the cost of production and the selling price at electric steel plants.

The Canadian steel industry has 12 blast furnaces with a total capacity of 12.2 Mt/y. Associated with these furnaces are 866 coke ovens with a capacity of 5.3 Mt/y. Virtually all of the blast furnace iron is used by the integrated steel companies for the production of steel. Algoma Steel's No. 6 blast furnace, its second largest, was shut down for 77 days for a scheduled reline, but, due to a softening steel market, it was not brought back into production when the reline was completed. Stelco Inc.'s Lake Erie Works blast furnace operations were interrupted for 10 days in June for unscheduled maintenance.

Electric Smelting Iron

Another source of primary iron is the nine electric furnaces at the ilmenite smelting facility of QIT-Fer et Titane Inc. at Tracy, Quebec. These furnaces have the capacity to produce 850 000 t/y iron as a coproduct with titanium dioxide. The facility operated near capacity during 1989.

This iron is used to produce three types of products: a range of specialty pig iron grades, which are sold mainly to the foundry industry; iron powder used by the powder metallurgy industry; and continuous cast steel billets sold to the steel industry for rerolling.

Direct Reduced Iron (DRI)

DRI is a semi-metallic product made by reducing iron ore in the solid state to approximately 95% metallic. Sidbec-Dosco Inc. has the only operating Midrex DRI plant in Canada, at Contrecoeur, Quebec. This plant has a capacity to produce 750 000 t/y, and it operated at close to its capacity during most of 1989. It was closed for 28 days in September for maintenance of the reduction furnace and gas reforming modules. DRI, together with scrap, is used to produce steel at the company's electric furnace steel mill.

Steel Mill Developments

The integrated steel producers are the major source of, and consumers of, primary iron in Canada. Developments at these companies are important in determining the future supply and demand for primary iron. Highlights by company are:

The Algoma Steel Corporation, Limited - Three capital equipment projects were under way and on schedule at Algoma Steel. These were construction of two ladle metallurgy stations, one in each of the company's steel-making shops, and a new continuous round caster. In January 1989, the company acquired 100% of Huron Steel Products (Windsor) Ltd. and Mohawk Metal Products Limited. Both companies are involved in the stamping, forming and assembly of steel parts for automotive and related industries.

Dofasco Inc. - Construction of a new $450 million integrated cold mill complex in Hamilton commenced in 1989. This complex will have the capacity to process approximately 1.2 Mt/y. Plans were announced to proceed with the study phase for a jointly owned hot dip galvanizing line, to be owned 50% by Dofasco and 50% by the joint venture consortium Nippon Kokan KK/National Steel Corporation. Work began on docking facilities, which includes new materials-handling equipment to increase the capacity to handle water-borne iron ore pellets.

Stelco Inc. - A $198 million flat rolled processing project was approved in April 1989. This project includes a new combination galvanizing/continuous annealing line, a pickle line upgrade at Hilton Works, and a second reheat furnace at Lake Erie Works. An agreement was reached to combine the facilities of Stelco's subsidiary, Canadian Drawn Steel Company, with those of Bliss & Laughlin Industries Inc., of Harvey, Illinois, into one operating company. Both companies manufacture cold finished bars. In September, Stelco also acquired the assets of CHT Steel Company Inc. of Richmond Hill, Ontario. This company operates a heat-treating facility for steel plates.

INTERNATIONAL EVENTS

Steel Developments

As production of steel is the major use for primary iron, it is necessary to monitor developments in the steel industries of the world to forecast supply and demand for primary iron; a short summary of such developments follows. Western world steel production, as calculated by the International Iron and Steel Institute (IISI), in the first nine months of 1989, increased 2.7% over the same period in the previous year. Production in the European Communities (EC) increased by 4.1% and in Japan by 2.1%. U.S. production declined by 0.8%. There was a softening of demand during the second half of the year which was illustrated by statistics from the IISI for the month of September; member countries reported that raw steel production in September was 1.3% below the September 1988 level. On a specific country basis, changes in production were: U.S. production was down 9%, the EC production was down 0.7%, and Japanese production was up about 1.0%. This overall decrease in production was attributed to lower levels of demand for consumer durables, especially automobiles. Increases in interest rates were also identified as a major factor in this decline.

U.S. steel exports increased a dramatic 215% to 2.7 Mt, the highest level since 1974. A significant portion of these exports came to Canada.

Blast Furnace Iron

In North America, pig iron production was maintained at a high level throughout the year. As a result, shortages of coke developed and a considerable tonnage of imported coke was used.

DRI Developments

Midrex plants account for about 64% of world DRI production; HYL I and HYL III plants are the second most important. Total DRI production was 14.13 Mt in 1988, or about 2% of world crude steel production. With electric furnace-based companies concentrating on improving product quality, and with continuing high prices for scrap, the proportion of DRI used should grow. DRI's inherent advantages of high purity and controlled chemistry have always been valued but, as long as ferrous scrap prices remained low, the growth potential for DRI was limited. This situation has now changed as scrap is expected to remain in short supply for the next decade.

World production in 1989 of DRI increased an estimated 14.6% compared to 1988. This increase was from established plants operating at close to capacity and from new plants. New facilities in Libya added an additional 1.1 Mt to world capacity. An additional 6.84 Mt of capacity is under construction, and 2.8 Mt of planned capacity has been delayed. Work on a further 5.9 Mt of capacity, that was under construction, has been suspended for a number of reasons. A major project in the Guayana region of Venezuela is in the feasibility study stage. This project would have two Midrex "MEGAMOD" plants with a total capacity of 2 Mt/y of DRI. They would be part of a complex with 3 Mt/y pelletizing capacity, a hot briquetted iron (HBI) plant, and an electric furnace steel mill with a capacity to produce 1 Mt/y of continuous cast slab. The principals in this proposal are Corporacion Venezolana de Guayana (CVG) and Kobe Steel, Ltd. (KSL). The projected start-up date for the project, which is called Comsigud, is late 1993. New DRI capacity using the rotary kiln process was installed by Davy McKee Corporation at Scaw Metals Ltd. in the United States.

Supplies of DRI were tight in 1989 with most of the capacity of merchant producers of HBI sold out for the immediate future.

NEW PRIMARY IRON TECHNOLOGIES

A number of new processes that provide an alternative to the traditional blast furnace have been developed. These processes are generally some form of direct smelting. They have economic and environmental advantages over the coke-oven blast furnace method, which requires coke and agglomerated iron ore. Agglomerated ore, whether pellets or sinter, requires significant energy to produce. Direct smelting processes that use concentrate or fines therefore represent considerable cost savings. As well, coke production requires high-grade metallurgical coal, whereas many direct smelting technologies require only pulverized lower grades of coal. A further consideration is environmental protection legislation that makes new coke ovens very expensive to build and to operate. Direct smelting processes have been engineered from original concepts to be environmentally compliant. Another advantage is the much smaller minimum economic size of direct smelting plants, an important capital cost consideration.

FERROUS SCRAP

CANADIAN EVENTS

Canadian demand for scrap remained high throughout the first three quarters of 1989, with consumption by steel producers increasing by 7.6%. This situation was a reflection of a continued high demand for steel.

In Canada, the steel industry consumed 5.97 Mt of scrap in the first nine months of 1989, compared to 5.55 Mt in the same period of 1988. Of this total, 2.2 Mt was internally generated by the industry and 3.8 Mt was purchased. The percentage of purchased scrap used by steel-makers increased by 15.4% in 1989.

PRICES

The price of scrap in Canada closely follows the trends in the United States because North America is effectively a single market for scrap.

The weekly composite price for shredded scrap, as quoted by the American Metal Market, was at a high of US$138/t in February 1989; the price averaged about US$135/t during March, April and May after which the price began to decline, reaching a low of US$113 at year-end. Shredded scrap is representative of scrap in general because it is a classification of scrap that is traded in high volumes.

Factors that contributed to the recent decline in prices for ferrous scrap include:

- a decline in the rate of increase in the use of continuous casting in both Canada and the United States;
- a slight decrease in the percentage of steel produced from electric furnace mills;
- a drop in demand for steel in both Canada and the United States during the last half of the year;

- a reduction in steel imports by the United States;

- an increase in steel exports by the United States; and

- a relatively low value for North American currencies, which stimulated exports of scrap overseas.

TRADE

Canada has historically been more than self-sufficient in scrap, but there are regional differences in supply and consumption that result in significant trade between Canada and the United States. A percentage of scrap, in excess of eastern Canadian needs, is exported to markets in the northeastern United States and offshore. On the other hand, the western Canadian market, which is generally deficient in local scrap, imports it from the American northwest and central regions. Scrap supply was a problem for Canadian steel companies in 1989 and imports from the United States increased by 79%, so that Canada became a net importer for the year.

The ferrous recycling industries in Canada and the United States share what they consider to be a single market. There are few restraints to the movement of scrap across the border and, consequently, prices in the United States have a major impact on those in Canada. During the last three years, 90% of Canadian scrap exports have gone to the United States, and virtually all Canadian imports originate in the United States.

Canada's recycling industry is efficient, quite highly mechanized and competitive internationally. The world market for ferrous scrap is very competitive and tends to fluctuate widely from year to year. Offshore countries which have a history of buying Canadian scrap include South Korea, Spain, Italy and Japan.

CANADIAN INDUSTRY STRUCTURE

The Canadian ferrous scrap industry comprises approximately 600 firms. These companies collect, store and process the ferrous scrap for sale to the user industries. Most of these firms are small and are involved only in the simple collection of scrap. Dealers who are also involved in the sorting and storage of scrap are fewer in number, while those who engage in capital-intensive scrap processing total only about 15. Scrap processing requires heavy equipment such as mechanical shredders, shears, presses and bundlers. This segment of the scrap industry produces the grades and types of scrap needed by the steel mills. A new competitively sized processor would have to spend in excess of $10 million on capital equipment today.

Statistical process control has been implemented at most of the large processors in response to market demand for higher quality scrap. Scrap is such an important raw material that it is common for Canadian steel producers to hold equity in scrap processing companies in order to reduce the risk of supply problems and to assure quality control.

SCRAP CLASSIFICATION

The producers of ferrous scrap describe unprocessed scrap by its origin. "Home scrap" is produced in the manufacture of steel mill products, whereas "prompt industrial scrap" is generated by the secondary manufacturing industry. "Obsolete scrap" comes from discarded machinery, equipment and structures.

Prompt and obsolete scrap is generally processed by the recycling industry. It is sorted into a number of product classes for which standards have been written by the Canadian Association of Recycling Industries.

Scrap classification is based on factors such as size, type of material, cleanliness, and residual alloying elements. The most common grades are as follows:

SCRAP PRODUCTS[1]

Class No.	Grade and Type
100	No. 1 Heavy Melting Steel
101	No. 1 Hydraulic Bundles
102	No. 1 Bushelling Prepared
103	No. 2 Heavy Melting Steel
104	Plate and Structural Steel
105	No. 2 Hydraulic Bundles
106	Hydraulic Silicon Bundles
107	No. 2 Bushelling Prepared
108	No. 1 Bushelling (Clips)
109	Short Shovelling Steel Turnings (Crushed)
110	Machine Shop Turnings
111	Mixed Turnings and Borings
112	Cast Iron Borings
113	No. 1 Shredded Scrap

SCRAP PRODUCTS[1] (cont'd)

Class No.	Grade and Type
114	No. 2 Shredded Scrap
115	Briquetted Steel Turnings, Alloy Free
116	Briquetted Steel Turnings, Alloyed
117	Foundry Steel

[1] From Canadian Association of Recycling Industries.

USES

Most ferrous scrap is used in electric furnace steel mills and integrated mills for the production of steel. The foundry industry is the second largest market for scrap. Minor markets include the production of iron powders, sinter, ferroalloys and abrasives.

Scrap used in the electric furnace steel industry must be carefully selected in order to minimize the melting time and the consequent cost of energy per tonne, and to maximize the furnace productivity. Depending on the grade of scrap, it can take from 1100 to 1200 kg of scrap to produce 1000 kg of steel. Tramp elements in scrap are a larger problem in electric furnaces than in integrated mills because there is less opportunity to remove them by oxidation and slagging, or to dilute them in the melt by addition of pig iron. Certain elements like tin are more difficult to remove than others. Thus, scrap grades low in tramp elements are preferred by electric furnace mills.

Basic oxygen furnaces (BOF) provide more scope for steel refining, and adjustments to steel chemistry, than an electric furnace does. In these, scrap can be added with molten iron from the blast furnace in proportions of about 30% and 70% respectively. In a BOF, scrap addition is necessary to absorb the energy released when the carbon in the molten iron is removed by oxidation. This exothermic energy has already been paid for in the production of the iron and its utilization to melt scrap effectively salvages the energy.

Apart from the saving in energy, ferrous scrap is usually much cheaper than iron produced in a blast furnace. Therefore, integrated mills focus some of their research effort on optimizing the amount of scrap charged to their steel furnaces.

On balance, integrated steel operations have more flexibility than electric furnaces with respect to the percentage of scrap in furnace feed, and they are also less dependent on scrap availability and price. For example, in periods of high demand when integrated mills operate near capacity, scrap usage is often maximized to boost steel production even if scrap prices are high. The reverse situation may apply when steel demand is low. Scrap use is governed by the need to utilize blast furnace iron at a minimum operating rate. In this case, it would be necessary to restrict scrap use to avoid over-production, even if the scrap was available at a very low price.

The ratio of purchased to internally-generated scrap in an integrated steel mill varies from year to year. In recent years, this ratio has varied from 0.93 to 1.17; in 1989, this ratio was 1.73, a change due to the increased use of continuous casting. The demand for purchased scrap may be dictated not only by considerations of minimum operating rates for blast furnaces, but also by the need to meet contractual purchases of iron ore and metallurgical coal. Such decisions may have been made in 1982 when the amount of purchased scrap that was used per tonne of steel was unusually low, even though the price of scrap was especially depressed. The expanding use of continuous casting equipment will more heavily influence the ratio in the future.

The increasing use of continuous casting and improvements in BOF will tend to reduce the levels of internally generated scrap and/or increase the demand for purchased scrap. This trend was illustrated in 1989.

In the case of the electric furnace steel industry, the price-demand relationship is much more direct because ferrous scrap is the principal raw material. Consequently, electric furnace mills can produce steel at considerably less cost than integrated mills in periods of low steel demand and low scrap prices, allowing them to capture market share and remain profitable. Many companies in this industry have been installing ladle refining facilities to improve the quality of their products, thereby allowing them to compete with the integrated mills over a larger product range.

OUTLOOK

Canadian production of primary iron is projected to decline slightly during 1990 as steel production is expected to drop back to the level of 1988. However, the integrated steel producers have recently become lower cost producers than the electric furnace-based industry and they are expected to gain market share. This change in competitiveness is from a significant increase in the price of scrap that has persisted for several years, and from increased productivity at integrated plants arising from high levels of capital expenditures on plant equipment made over the last five years or so. Since the integrated plants require some primary iron, iron production is forecast to decline less than steel production. In fact, over 1991 and 1992, iron production is forecast to remain fairly constant at 1990 levels, even though steel production is forecast to decline slightly.

In the medium term, 5 to 10 years, primary iron production should increase as Canadian steel production increases in the context of greater trade with the United States under the Free Trade Agreement. Free trade is expected to have two effects: one, stimulate the domestic steel-intensive secondary manufacturing industries thus boosting domestic demand, and two, provide good potential for exports of steel mill products to the United States. Since the U.S. market still imports over 25% of its steel requirements, the Canadian steel industry could displace some of the tonnage that the United States imports from offshore. Furthermore, the Canadian steel industry is expected to continue to be competitive in some offshore markets due to higher productivity and currency exchange rates.

In the longer term, the export potential is good because the Canadian industry is modern, efficient, and is emphasizing the market for high value added products where there is less competition from the developing nations that have lower operating costs.

Internationally, steel demand and production have been growing since early 1987, and by the middle of 1989, when some softening of demand became apparent, had posted a steady growth for 26 or 27 months. The world market is expected to maintain 1989 levels or soften slightly in 1990. Growth is expected to begin again in 1991 and 1992 due to an expected improvement in the economy. North American output of steel is expected to improve at somewhat less than 1%/y during the first half of the decade after declining by about 5% in 1990. From a decline in 1990, the European steel industry should perform slightly better than the industry in North America, with growth averaging slightly more than 1%/y during the 1990s. Japanese production is forecast to increase at a rate between 1% and 2% as a result of high levels of domestic demand and potential to increase export sales. Japanese production is not expected to decline in 1990. Steel production in the newly industrialized nations is expected to increase at over 2%/y throughout the decade.

The outlook for DRI is quite positive because ferrous scrap is forecast to be in short supply and high-priced in the medium term. Furthermore, the availability of hot metal from blast furnaces is unlikely to increase as older equipment reaches the end of its economic life. The steel industry will wait for the new reduction technologies to be commercially proven over the next 5 to 10 years, with the likely result of a shortage of hot metal. This shortfall could well be supplied by DRI.

The future for iron produced by newer technologies also looks good because many direct smelting processes such as the Corex process; the XR process by Kawasaki Steel Corporation; direct bath smelting of iron ore, a joint venture of CRA Limited of Australia and Kloeckner Stahlforschung of West Germany; and the Elkem Polar process by Elkem a/s of Norway, have reached technical maturity, appear economically viable, and await verification at commercial scale.

Scrap prices, which softened slightly in the last half of 1989, are expected to continue to decline slightly in 1990 and to begin to increase in 1991 and 1992. Canadian scrap prices should be supported by prices in the United States, where steel production is expected to remain considerably higher than in the years prior to 1988, due to restrictions on steel imports and because U.S. steel producers have become much more productive and competitive with imported steel.

Integrated and electric furnace mills are experiencing rapid technological change, which will have a long-term impact on the scrap market. Recent research and development efforts have focused on increasing the amount of scrap that can be used in the basic oxygen furnace. New developments that improve the existing processes include systems in which fuel and oxygen are blown into the BOF to preheat the scrap charge, and Lance Bubbling Equilibrium (LBE) equipment in which inert gases are blown through the bottom of a BOF-type vessel. The more efficient mixing created by the LBE system results in higher yields, increases the amount of scrap that can be charged and improves the quality of the steel.

Technical developments in the electric furnace mills have centred on the treatment of the steel in a separate holding vessel, a process called ladle metallurgy. This technique frees the main furnace for more primary production and allows a more precise final treatment to adjust the chemistry of the steel. The improved products will allow electric furnace mills to capture a greater share of the steel market and thereby increase the demand for scrap.

Another technology that could be rapidly adopted by the industry is the continuous casting of thin slab that could be easily rolled into sheet products. Currently, sheet can be produced only by integrated mills. Nucor Corporation of the United States has constructed a mill based on the "thin slab casting" technology. Initial production of test coils of steel began in mid-year and by year-end the plant was producing coils of commercial quality. This plant has become a test of the process and, as such, has been closely watched by the world's steel producers. A second plant using this technology has been contracted for by the Yieh Loong Group of Taiwan.

Scrap usage in 1990 is expected to be close to the levels of 1988. In the medium term, to 1995, usage should increase 4-5%/y as more continuous steel is produced and a greater percentage of the steel made in North America is produced in electric furnaces. The growth rate after 1995 is forecast to slow to approximately 2%/y.

For the scrap recycling industry, the anticipated rising demand for higher quality scrap, especially in terms of low levels of tramp elements and more desirable product forms, will likely require the installation of more sophisticated process equipment. This could include x-ray spectrometers to analyze scrap, mechanical separators, and high pressure bailers and briquetting machines for the production of high density product. Also, there will likely be an introduction of better shredders that would improve the separation of ferrous metal from nonferrous metals and nonmetallic components in processing obsolete automobiles.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, IMPORTS OF STEEL SCRAP, BY PROVINCE OF ENTRY, 1986-88

		1986		1987		1988[1]	
		World	United States	World	United States	World	United States
Nova Scotia	tonnes	38	38	-	-	10	10
	$000	10	10	-	-	2	2
New Brunswick	tonnes	65	65	67	67	134	134
	$000	7	7	15	15	47	47
Quebec	tonnes	31 770	31 757	22 802	22 751	52 366	52 134
	$000	3 521	3 519	2 692	2 684	8 573	8 496
Ontario	tonnes	274 054	273 988	249 314	249 101	327 002	326 667
	$000	28 458	28 374	32 931	32 739	41 935	41 815
Manitoba	tonnes	21 568	21 568	21 035	21 035	51 341	51 341
	$000	1 420	1 420	1 754	1 754	8 982	8 982
Saskatchewan	tonnes	42 006	42 006	105 976	105 976	213 208	213 208
	$000	3 620	3 620	7 889	7 889	23 043	23 043
Alberta	tonnes	19 939	19 939	11 353	11 353	18 597	18 597
	$000	1 875	1 875	1 043	1 043	2 466	2 466
British Columbia	tonnes	5 369	5 369	4 102	4 102	3 132	3 132
	$000	446	446	428	428	724	724
Total	tonnes	394 809	394 731	414 649	414 386	665 829	665 213
	$000	39 356	39 271	46 753	46 553	85 803	85 575

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning in 1988, imports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Steel Scrap includes H.S. classes 7204.29, 7204.30, 7204.41, 7204.49 and 7204.50.

- Nil.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, EXPORTS OF STEEL SCRAP, BY PROVINCE OF LADING, 1986-88

		1986		1987		1988[1]	
		World	United States	World	United States	World	United States
Newfoundland	tonnes	1 302	–	7 028	–	13 954	6 910
	$000	86	–	656	–	2 013	940
Nova Scotia	tonnes	1 575	1 563	5 712	5 406	5 997	5 327
	$000	247	244	1 123	1 071	1 167	806
Prince Edward Island	tonnes	104	104	–	–	–	–
	$000	15	15	–	–	–	–
New Brunswick	tonnes	10 669	2 883	3 147	3 017	505	431
	$000	1 472	361	694	651	95	82
Quebec	tonnes	177 412	25 922	116 775	27 997	171 791	41 813
	$000	15 299	3 239	13 848	4 019	24 709	7 464
Ontario	tonnes	538 491	466 004	626 854	502 734	1 174 421	1 094 502
	$000	50 725	42 987	79 437	64 574	103 855	84 324
Manitoba	tonnes	5 248	5 248	7 408	7 355	8 126	7 731
	$000	813	813	780	772	2 201	2 015
Saskatchewan	tonnes	86	–	6 016	6 016	3 313	3 282
	$000	26	–	1 148	1 148	488	479
Alberta	tonnes	299	168	1 048	632	2 395	2 018
	$000	100	63	196	114	1 044	808
British Columbia	tonnes	97 602	81 070	129 000	116 531	173 100	166 826
	$000	11 290	8 536	13 049	10 658	24 220	21 334
Yukon	tonnes	1 429	127	–	–	–	–
	$000	143	7	–	–	–	–
Total	tonnes	834 218	583 089	902 987	669 688	1 553 602	1 328 840
	$000	80 216	56 265	110 931	83 007	159 801	118 263

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning in1988, exports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Steel Scrap includes H.S. classes 7204.29, 7204.30, 7204.41, 7204.49 and 7204.50.

– Nil.

Note: Totals may not add due to rounding.

TABLE 3. CANADA, EXPORTS OF STAINLESS STEEL SCRAP, BY PROVINCE OF LADING, 1986-88

		1986		1987		1988[1]	
		World	United States	World	United States	World	United States
Newfoundland	tonnes	–	–	–	–	–	–
	$000	–	–	–	–	–	–
Nova Scotia	tonnes	211	–	1 131	675	654	232
	$000	236	–	1 072	750	747	109
New Brunswick	tonnes	115	27	1 138	1 112	276	208
	$000	167	79	369	348	234	131
Quebec	tonnes	3 602	2 004	2 975	1 748	1 772	1 099
	$000	2 769	1 302	2 550	1 546	2 995	2 001
Ontario	tonnes	20 594	7 103	18 441	6 653	18 570	10 420
	$000	17 457	4 949	16 394	4 462	25 785	10 512
Manitoba	tonnes	247	247	1 838	1 659	1 659	1 399
	$000	170	170	409	211	2 215	1 823
Saskatchewan	tonnes	4	4	18	18	–	–
	$000	8	8	12	12	–	–
Alberta	tonnes	171	163	177	140	416	219
	$000	146	139	148	118	745	287
British Columbia	tonnes	2 159	477	2 631	524	7 898	5 160
	$000	1 583	287	1 840	286	5 000	1 093
Total	tonnes	27 104	10 026	28 349	12 530	31 245	18 737
	$000	22 536	6 935	22 794	7 733	37 723	15 959

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning in 1988, exports are based on the new Harmonized System and may not be in complete accord with previous method of reporting. Stainless Steel Scrap includes H.S. class 7204.21.

– Nil.

Note: Totals may not add due to rounding.

TABLE 4. CANADA, CRUDE STEEL PRODUCTION, SHIPMENTS AND TRADE 1987-89

	1987r	1988	1989
		(tonnes)	
Furnace capacity, January 1[1]			
Steel ingot			
Basic open-hearth	1 000 000	750 000	500 000
Basic oxygen converter	11 279 000	11 810 000	736 900
Electric	5 563 450	6 253 450	6 393 450
Total	17 842 450	18 813 450	18 630 350
Steel castings	799 030	399 352	403 590
Total furnace capacity	18 641 480	19 212 802	19 033 940
Production			
Steel ingot			
Basic open-hearth and Basic oxygen	10 216 881	9 927 173	10 608 346
Electric	4 405 280	4 800 676	4 724 095
Total	14 622 161	14 727 849	15 332 441
Continuously cast, included in total above	7 215 744	10 299 910	11 760 472
Steel castings[2]	114 886	137 865	125 698
Total steel production	14 737 047	14 865 714	15 458 139
Shipments from plants			
Steel castings	100 378	130 074	x
Rolled steel products	12 748 778	13 261 522	13 325 808
Total	12 849 156	13 391 596	x
Exports of iron and steel to all countries	. .	. .	4 564 000
Imports of iron and steel to all countries	. .	. .	3 033 000

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] The capacity figures, as of January 1 in each year, take into account both new capacity and obsolete capacity anticipated for the year. [2] Produced mainly from electric furnaces.

r Revised; x Confidential; . . Not available.

TABLE 5. CANADA, PIG IRON PRODUCTION, SHIPMENTS, TRADE AND CONSUMPTION, 1987–89

	1987	1988	1989
		(tonnes)	
Furnace capacity January 1[1]			
Blast	11 689 000	12 229 000	12 976 000
Electric	700 000	700 000	700 000
Total	12 389 000	12 929 000	13 676 000
Production			
Basic	. .	. .	. .
Foundry iron[2]	. .	. .	. .
Total	9 719 289	9 498 264	10 138 904
Imports			
Tonnes	9 794	. .	. .
Value ($000)	3 165	. .	. .
Exports			
Tonnes	446 950	. .	. .
Value ($000)	109 410	. .	. .
Consumption of pig iron			
Steel furnaces[3]	9 737 133	9 826 869	10 128 221
Consumption of iron and steel scrap			
Steel furnaces	7 143 453	7 476 173	7 789 670

Sources: Statistics Canada; Primary Iron and Steel (monthly).

[1] The capacity figures, as of January 1 in each year, take into account both new capacity and obsolete capacity anticipated for the year. [2] Includes malleable iron. [3] Includes pre-reduced iron.

. . Withheld to avoid disclosing company proprietary data.

TABLE 6. CANADIAN CONSUMPTION OF IRON AND STEEL SCRAP

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989p
	(000 tonnes)									
Used in steel furnaces	7 501	6 845	5 492	6 449	7 383	7 034	6 948	7 143	7 476	7 790
Used in iron foundries	470	500	448	416	552	551	578	645	600e	625e
Other[1]	770	926	837	475	500	550	300	325	425e	485e
Total	8 741	8 271	6 777	7 337	8 435	8 135	7 826	8 200	8 500e	8 900e

Sources: Annual Census of Manufactures; Catalogue 41-001 Primary Iron and Steel; Canadian Foundry Association.

[1] Includes mainly steel pipe mills, motor vehicle parts, and railway rolling stock industries.

p Preliminary; r Revised; e Estimated.

TABLE 7. AUTOMOBILE SHREDDERS IN CANADA

Company	Location	Capacity (tonnes month)
Intermetco Limited	Hamilton, Ontario	8 000
United Steel and Metal, division of USACO Limited	Hamilton, Ontario	5 000
Bakermet Inc.	Ottawa, Ontario	8 000
Industrial Metal, division of Co-Steel Inc.	Toronto, Ontario	10 000
Zalev Brothers Limited	Windsor, Ontario	8 000
Sidbec-Feruni inc.	Contrecoeur, Quebec	8 300
Fers et Métaux Recyclés Ltée	Longueuil, Quebec Laprairie, Quebec	4 000 4 000
Associated Steel Industries Ltd.	Montreal, Quebec	8 000
Native Auto Shredders	Regina, Saskatchewan	6 000
Cyclomet	Moncton, New Brunswick	4 000
Navajo Metals, division of General Scrap & Car Shredder Ltd.	Calgary, Alberta	3 000
Stelco Inc.	Edmonton, Alberta	8 000
Richmond Steel Recycling Limited	Richmond, British Columbia	5 800
General Scrap & Car Shredder Ltd.	Winnipeg, Manitoba	3 000
Total		85 100

TABLE 8. WORLD RAW STEEL PRODUCTION, 1988 AND 1989

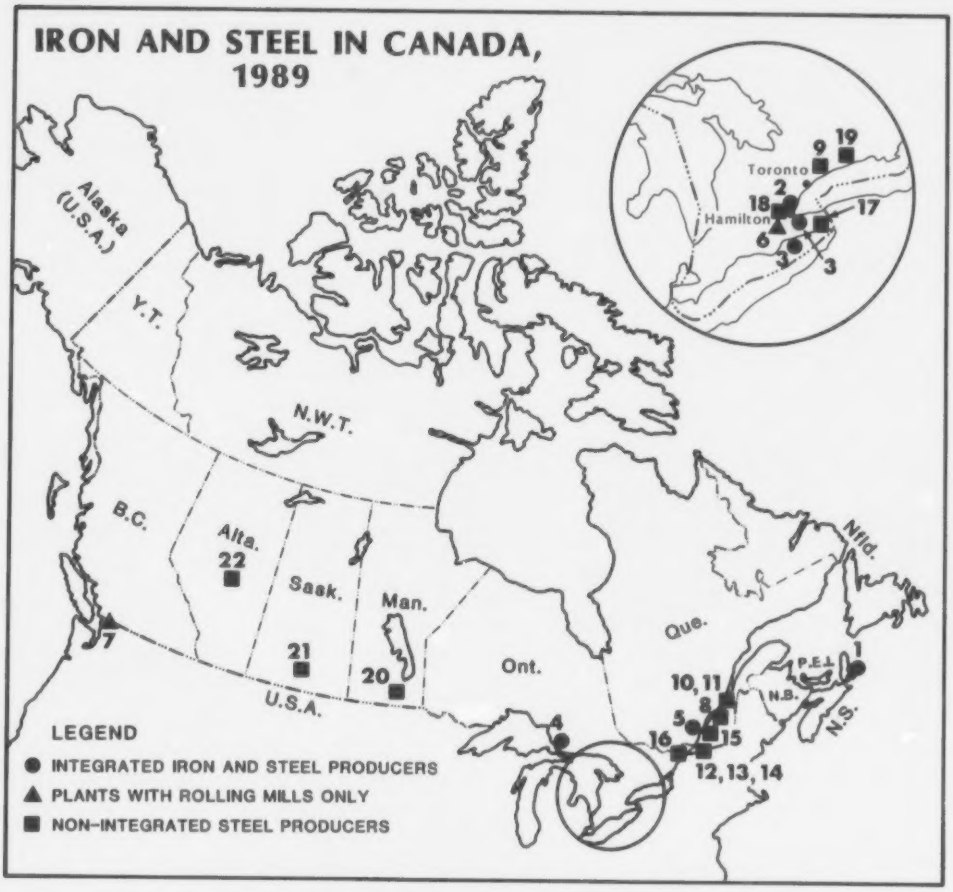
	1988[r]	1989[e]
	(000 tonnes)	
U.S.S.R.	163.0	160.7
Japan	105.7	107.9
United States	90.7	88.9
People's Republic of China	59.4	61.3
West Germany	41.0	41.0
Italy	23.7	25.1
Brazil	24.7	25.0
Republic of Korea	19.1	21.9
France	19.1	19.3
United Kingdom	19.0	18.8
Czechoslovakia	15.4	15.5
Canada	15.2	15.5
Poland	16.9	15.2
India	14.3	14.4
Romania	14.5	13.5
Spain	11.9	12.7
Belgium	11.2	10.9
South Africa	8.8	9.4
Taiwan	8.3	8.7
East Germany	8.1	7.9
Turkey	8.10	7.8
Mexico	7.8	7.7
North Korea	6.8	6.9
Australia	6.4	6.6
Netherlands	5.5	5.7
Sweden	4.8	4.7
Austria	4.6	4.7
Yugoslavia	4.5	4.5
Argentina	3.6	3.9
Luxembourg	3.7	3.7
Venezuela	3.7	3.5
Hungary	3.6	3.5
Finland	2.8	2.9
Bulgaria	2.9	2.8
Others	21.4	21.2
Total	780.2	783.7

Source: International Iron and Steel Institute.
[e] Estimated; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 9. CAPACITY AND PRODUCTION OF DIRECT REDUCED IRON (DRI), 1987 AND 1988

Country	Capacity		Production	
	1987	1988	1987	1988
	(Mt y)		(Mt)	
Argentina	0.93	0.93	1.04	1.07
Brazil	0.31	0.31	0.20	0.20
Burma	0.04	0.04	0.02	0.20
Canada	1.00	1.00	0.73	0.77
Egypt	0.72	0.72	0.47	0.77
India	0.30	0.30	0.19	0.19
Indonesia	2.00	2.00	1.03	0.98
Iran	0.73	0.73	0.00	0.00
Iraq	0.54	1.47	0.00	0.02
Malaysia	1.25	1.25	0.59	0.50
Mexico	2.03	3.03	1.56	1.63
New Zealand	0.17	0.17	0.00	0.00
Nigeria	1.02	1.02	0.14	0.14
Peru	0.12	0.12	0.06	0.05
Qatar	0.40	0.40	0.47	0.50
Saudi Arabia	0.80	0.80	1.04	1.08
South Africa	1.28	1.28	0.84	0.73
Sweden	0.00	0.00	0.00	0.00
Trinidad and Tobago	0.84	0.84	0.49	0.59
United Kingdom	0.80	0.80	0.00	0.00
United States	0.40	0.40	0.21	0.29
U.S.S.R.	1.67	1.67	1.26	1.60
Venezuela	4.50	4.50	3.12	2.73
West Germany	0.40	0.48	0.20	0.27
Total	22.25	24.26	13.66	14.31

Source: Midrex Corp., North Carolina, United States.



IRON AND STEEL IN CANADA, 1989

Alaska (U.S.A.)
Y.T.
N.W.T.
B.C.
Alta.
Sask.
Man.
Ont.
Que.
Nfld.
P.E.I.
N.B.
N.S.
U.S.A.
Toronto
Hamilton
1
2
3
4
5
6
7
8
9
10, 11
12, 13, 14
15
16
17
18
19
20
21
22
LEGEND
● INTEGRATED IRON AND STEEL PRODUCERS
▲ PLANTS WITH ROLLING MILLS ONLY
■ NON-INTEGRATED STEEL PRODUCERS

Integrated iron and steel producers
(numbers refer to locations on map above)

1. Sydney Steel Corporation (Sydney)
2. Dofasco Inc. (Hamilton)
3. Stelco Inc. (Hamilton and Nanticoke)
4. The Algoma Steel Corporation, Limited (Sault Ste. Marie)
5. Sidbec-Dosco Inc. (Contrecoeur)

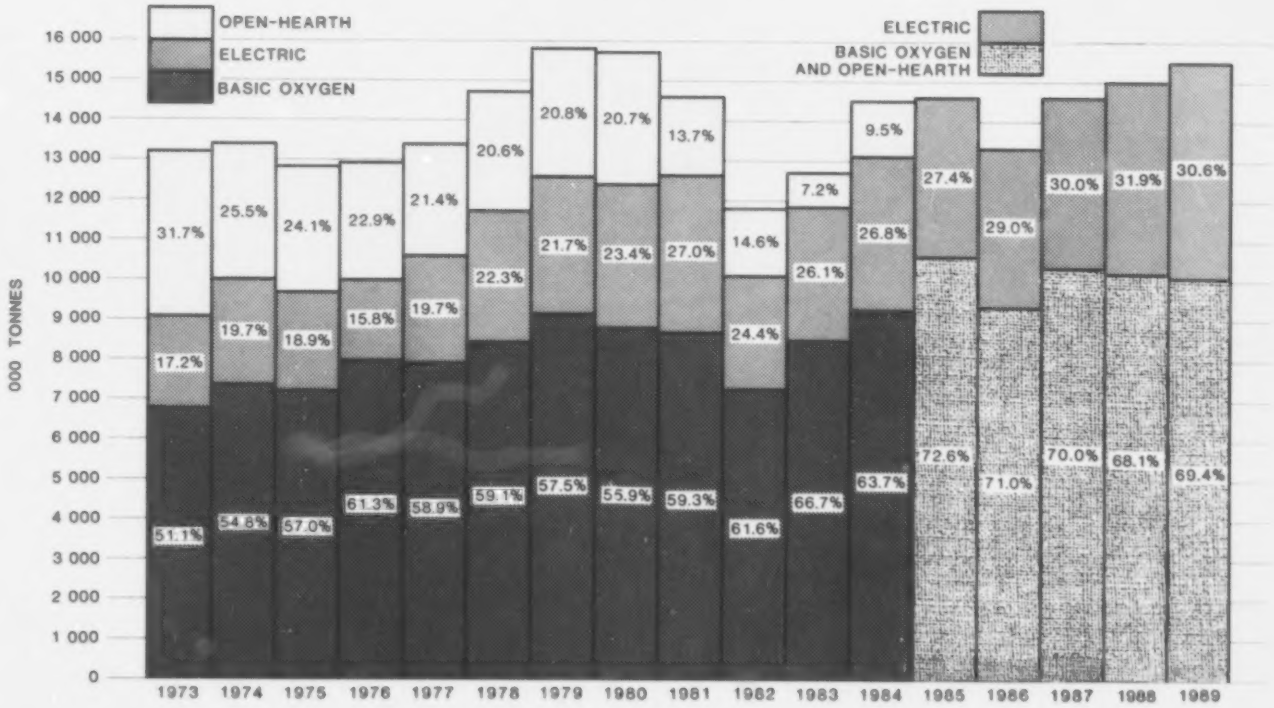
Plants with rolling mills only

6. Stanley Strip Steel division of Stanley Canada Inc. (Hamilton)
7. Pacific Continuous Steel Limited (Delta)

Non-integrated steel producers

8. QIT-Fer et Titane Inc. (Sorel)
9. Courtice Steel Inc. (Cambridge)
10. Stelco Inc. (Contrecoeur)
11. Atlas Stainless Steels, division of Sammi Atlas Inc. (Tracy)
12. Sorel Forge, division of Slater Industries Inc.
13. Canadian Steel Foundries, division of Hawker Siddeley Canada Inc. (Montreal)
14. Canadian Steel Wheel Limited (Montreal)
15. Sidbec-Dosco Inc. (Montreal and Longueuil)
16. Ivaco Inc. (L'Orignal)
17. Atlas Specialty Steels; division of Sammi Atlas Inc. (Welland)
18. Hamilton Specialty Bar, division of Slater Industries Inc.
19. Co-Steel Inc. (Whitby)
20. Manitoba Rolling Mills, subsidiary of Canam Manac Group Inc., The
21. IPSCO Inc. (Regina)
22. Stelco Inc. (Edmonton)

CANADA, PRODUCTION OF STEEL BY FURNACE TYPE



Salt 1989

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DOMESTIC PRODUCTION AND DEVELOPMENTS

In 1989, Canadian production of salt was estimated at 10.56 Mt, a 3.3% decrease from 1988. Salt production in Quebec fell drastically due to a six-month strike that affected the underground mine between April and October. Shipments of all types of salt rose 6% to 11.3 Mt of which two thirds was from Ontario. Rock salt shipments accounted for 69% of total shipments, followed by salt in brines (24%) and evaporated salt (7%). Increases in sales were reported in Nova Scotia, Ontario and Alberta. The average unit value of salt shipments was estimated at $23.80/t, a 3% increase over 1988. The salt production capacity in Canada was estimated at 12.6 Mt of which rock salt accounted for 68%, followed by captive brines (24%) and evaporated salt (8%); the capacity increased 26% over the last six years and was led by an increase in the brining capacity (50%) while rock salt capacity expanded 25%. Evaporated salt capacity remained fairly flat with a small 4% increase, although it underwent several major modernizations during this period. In 1989, captive brining plants operated at 90% capacity; rock salt mines and evaporated salt facilities operated at 84% and 83% respectively. The overall salt operations ran at an average of 83.9% of capacity, compared to 88.6% in 1988.

The rock salt de-icing market was strong in 1989 due to severe weather conditions that prevailed during the winter of 1988-89, in particular in central and Atlantic Canada. The introduction of new salt-based de-icing products and the desire for safer roads have reduced, in part, the pressures for costly de-icing alternatives such as calcium-magnesium acetate (CMA). Sales of evaporated salt were stable during 1989. The water conditioning salt market continued to show some growth all across Canada, but in particular in western and central Canada municipalities. Shipments to the chloralkalies sector were flat due to lower operating rates experienced by the pulp and paper industry during 1989; pulp mills operated at 96% of capacity, a 2% decline from 1988, and production of pulp and paper products declined 2% over 1988, triggered by reduced sales of wood pulp. The chloralkalies industry has been facing an unbalanced market between chlorine and caustic soda; while the demand for the latter was strong in 1989 due to good performance in the chemical sector, the demand for chlorine diminished. The chlorine markets were affected by environmental concerns related to the depletion of the ozone layer and the presence of dioxins in mill effluents. The immediate impact resulted in the search for non-chlorine alternatives. In this regard, the conversion to the sodium chlorate process by the pulp and paper industry reflected this concern as well as the trend toward higher efficiency and better profitability.

Atlantic region

Salt production in the Atlantic provinces is from an underground rock salt mine at Pugwash, Nova Scotia, an underground potash and salt mine at Sussex, New Brunswick and a brining operation near Nappan, Nova Scotia.

In New Brunswick, Potash Company of America, division of Rio Algom Limited, produces potash and by-product salt at its underground mine near Sussex. Salt is extracted at a rate of 400 000-500 000 t/y and is sold mainly to the eastern United States. Reserves are estimated to be large enough to operate for as long as potash is extracted, which is for at least 20 years. Salt is marketed for road de-icing and chemical plants under a sales contract with Akzo Salt Ltd. (formerly Iroquois Salt Products Ltd.).

In Nova Scotia, The Canadian Salt Company Limited operates an underground rock salt mine at Pugwash in Cumberland County, with a rated capacity of approximately 1.2 Mt/y. Most of the salt from this mine is used for snow and ice control. At the evaporated salt plant, saturated brine is fed to a quadruple effect vacuum pan, rated at 13 t/h, where brine solution is evaporated to produce high-quality salt crystals for use in the chemical and food industries. In 1989, a $7 million expansion and upgrading project continued. An access ramp and development work at the 276 m sub-level were completed while the preparation work at the 300 m level was reported ahead of schedule for mining to start in 1990. Ventilation drifts and cross-cuts are to be completed by mid-1990. Draft at dock site underwent expansion to accommodate barge-load capacity of up to 16 000 t of salt per barge, a 45% increase from 1988. A new brine evaporator, installed late in 1988, performed well in 1989 as start-up problems were minimal. The Canadian Salt Company Limited acquired the assets of Scotia Salt from Avalon Salt of Newfoundland. Scotia Salt had operated a bagging plant for imported solar salt. Canadian Salt is expected to continue to operate the 50 000 t/y plant with product from its own solar salt operation in the Bahamas.

Domtar Chemicals Group, a division of Domtar Inc., has a brining operation at Nappan in Cumberland County, Nova Scotia. Evaporated salt products are used for table salt, fisheries and water conditioning. In 1989, the Domtar plant ran at a very high operating rate. With its high level of electricity consumption, the proposals for rate hikes made by Nova Scotia Power Corporation (NSPC) during the year were opposed by Domtar. The 18% increase sought by NSPC would be effective in April 1990.

Quebec

In 1989, the operations at Seleine Mines Inc. were affected by a six-month strike which started in early April and significantly reduced the 1989 output from this mine. Close to 150 workers were involved in the strike. Meanwhile, the company pursued its development work for future production at the 268 m mining level, which is expected to start in 1991. Mineable reserves at the 223 m level are forecast to be depleted during 1990 while reserves at the 173 m level may last up to 1993. Each level has an average reserve life of five years, holding about 8 Mt per level. An access ramp and construction work at the 260 m sub-level were completed during the year. An aboveground covered storage facility was expanded at the mine site to 330 000 t. In 1990, secondary and tertiary impact crushers will be replaced by rolling mill crushers which are expected to increase the salt recovery rate by 5% to 85%.

Ontario

During 1989, production was from two rock salt mines (Goderich and Ojibway) and from brining operations at Goderich, Sarnia, Windsor and Amherstburg.

At Goderich, Domtar Chemicals Group operates an underground rock salt mine, where it commissioned a new $10 million underground mill early in 1989. In November, Domtar Inc. of Montreal, Quebec, sold its Sifto Salt division to Carey Salt Holdings, Inc. of Mission, Kansas. The acquirer already owned salt operations in North America with assets of Great Salt Lake Minerals & Chemicals Corporation (GSL), Carey Salt Co. and American Salt Company. Domtar's salt is marketed mainly for ice control and is sold mainly in eastern Canada, the north-central United States, and in regions accessible through the Mississippi River system. Evaporated salt is also produced at the Domtar brining operation located near Goderich.

The Canadian Salt Company Limited produces both rock salt from the Ojibway underground mine and vacuum salt products from brine wells near Windsor. The mine capacity exceeds 2.5 Mt/y. Rock salt is extracted from a depth of 297 m while brine is pumped from 427 m and 457 m. In 1989, underground development work continued in the southwest area; more than half of the pre-production development was reported completed.

In the vicinity of Amherstburg, General Chemical Canada Ltd. operates a brining operation for the manufacture of sodium carbonate and by-product calcium chloride. At Sarnia, Dow Chemical Canada Inc. produces brines from wells for the production of caustic soda and chlorine.

Prairie Provinces

In Saskatchewan, four companies produce salt from the Middle Devonian Prairies formation. International Minerals & Chemical Corporation (Canada) Limited (IMCC) supplies by-product rock salt from its potash operation at Esterhazy. Its salt is distributed locally for road de-icing. Domtar Inc. operates a brining operation, near Unity, for the production of fine vacuum pan salt; Unity has the only fused salt facility operating in Canada as other salt operations switched to salt pelletizing through compaction. Environmental considerations over air emissions from this unit's furnace may affect the future of this production. Domtar Inc. acquired the assets of Nickel Salt of Saskatoon; the firm recovered salt by processing waste salt from a nearby potash operation at Patience Lake. The capacity of production was reported to be in the range of 20 000-30 000 t/y. The Canadian Salt Company Limited at Belle-Plaine produces table salt from by-product brine sourced from an adjacent potash solution mine operated by Kalium Chemicals, a division of Kalium Canada, Ltd. Saskatoon Chemicals, a division of Weyerhaeuser Canada Ltd., produces brines from wells near Saskatoon for the manufacture of caustic soda and chlorine.

In Alberta, two producers operate brining operations: at Fort Saskatchewan near Edmonton, Dow Chemical Canada Inc. extracts salt brine for the manufacture of chloralkalies and, at Lindberg, The Canadian Salt Company Limited produces fine vacuum pan salt. In 1989, new brine wells were drilled for solution mining by next year; no change in production capacity is expected.

British Columbia

There is no production of salt in this province where three companies operate six chloralkalies plants. The latter use solar salt imported from Mexico, the United States and Chile.

CONSUMPTION

In 1988, the apparent consumption of salt in Canada was estimated at 8.9 Mt, a 4% increase over 1987. The use of salt for snow and ice control increased 7% to 6.0 Mt in the fiscal year of June 1988 to June 1989. Road de-icing and industrial chemicals remained the major usages, accounting together for 95% of total consumption, while the remainder was used mainly for water softening and food processing.

Ontario and Quebec accounted for two thirds of the domestic market, followed by western Canada (24%) and the Atlantic provinces (10%). The captive market contributed 38% to the total domestic sales of salt. The remainder was sold in the merchant market which was mostly supplied by domestic shipments (80%); import tonnages accounted for only 20% and were shipped, almost evenly split, into central and western Canada.

Worldwide, salt is largely used as a chemical raw material accounting for 60% of world consumption, followed by table salt (19%) and road de-icing (11%); the remaining 10% was used in animal feed and water treatment. The consumption pattern differs in North America where the chemical industry consumes about half of total production, followed by highway usage and the food industry.

The industrial chemicals industry consumes salt for the manufacture of chloralkalies such as caustic soda (sodium hydroxide), chlorine and sodium chlorate. Salt for four caustic soda and chlorine plants in Canada is obtained from on-site brining and natural brines; others use mined rock salt or imported solar or evaporated salt. Other industrial chemicals that require significant quantities of salt include sodium bicarbonate, sodium chlorite, sodium hypochlorite and sodium carbonate (soda ash).

Chlorine, which is a major market for salt, is currently under investigation as the principal pulp-bleaching agent responsible for the presence of traces of dioxin (2, 3, 7, 8,-TCDD) and furan (2, 3, 7, 8,-TCDF) in certain pulp and paper mill effluents in North America. These chlorinated compounds have been identified as carcinogenic to some animals; however, their effect on humans is controversial. The Canadian government intends to introduce new regulations for pulp and paper mill effluents in early 1990; the regulations are expected to call for the complete elimination of dioxin and furan discharges by 1994 from all pulp and paper mills in Canada. The Environmental Protection Agency in the United States has already set stringent limits to control dioxin contamination in waste water, following a study indicating that effluents from 104 paper mills in the United States show dioxin levels ranging from barely detectable to 311 parts per trillion.

The Pulp and Paper Research Institute of Canada and the Canadian Pulp and Paper Association proposed elimination of these compounds by reducing their levels in waste discharges through a series of prescriptions: controlling wood supply, reformulating washing additives, improving bleaching controls and installing biological treatment to mill effluents. Most mills in Canada have carried out extensive process modifications and effluent treatments; several opted for reducing chlorine usage by installing other bleaching processes such as extended lignification, oxygen delignification, sodium chlorate bleaching or hydrogen peroxide bleaching.

Substitution of chlorine by sodium chlorate has been occurring at a fast pace during the 1980s, affecting the supply for sodium hydroxide and sodium chlorate. Demand for salt is expected to remain firm in this sector, despite the environmental concern with dioxin, as salt consumption will capture opportunities in the requirements for sodium chlorate.

Salt remains the primary de-icing product although several other chemicals are used to some extent for snow and ice control. Calcium chloride is the second largest de-icer being effective at temperatures down to -20°C, but it costs 2.5 times the cost of salt. Urea is used in corrosion-prone areas such as in airports. Mixtures of salt, sand and calcium chloride are extensively used for highways, but their usage in urban areas is limited due to their reduced ice-melting characteristics and the possibility of hazards related to sand accumulation.

The growing concerns over the degradation of the environment and the corrosion of infrastructures such as bridge decks and parking lots have led to numerous experiments with de-icing salt alternatives. Salt producers have introduced into the marketplace new, low-corrosion de-icers which are reported to perform more effectively at lower temperatures than salt and to reduce corrosion considerably. Other methods are presently under investigation in Canada, including cathodic protection of bridge structures, salt additives into asphalt mixtures and concrete sealants.

In Ontario, alternative chemicals have been tested since 1986. Calcium Magnesium Acetate (CMA) and Sodium Formate (NaFo) were used near Toronto and Ottawa, and have shown comparable effectiveness to salt, but at a much higher cost. Further road tests are to be carried out in Ottawa during the winter of 1989-90. Other chemicals have been contemplated as potential deicers, such as magnesium salt and sodium nitrate.

The market for de-icing salt is extremely elastic and varies from year to year depending on weather conditions. Although salt is recognized as highly corrosive, its low cost and high availability are factors that appeal to most ice control agencies, which are constantly pursuing the optimization of the application rate required to ensure safe roads.

Since mid-1987, the Roads and Transportation Association of Canada (RTAC) has been coordinating an extensive project for evaluating degradation of highways and related infrastructures. The Canadian Strategic Highway Research Program (C-SHRP) is a $5 million project funded by provincial and federal grants over a five-year period. It has four elements: monitoring, technology transfer, and integrated and complementary research programs linked to a U.S.-SHRP program. The C-SHRP program encompasses special research on pavements, structures and snow and ice control. Its medium-term objective is to develop a comprehensive data-base on research results and experiments relative to pavement and material (asphalt) performance.

Other sectors that consume salt include water softening, food processing and the fishery industry, which together account for close to 5% of total consumption in Canada. Salt consumption in Canada for water softeners was estimated at 200 000 t for the residential market. The bulk of Canadian production was consumed in the domestic market as trade in conditioning salt was estimated to be small. A typical annual consumption per household in Canada ranged between 350-450 kg/y of salt. The bulk of the market was reported to be located in the suburban and rural areas where hard water is seldom treated on a large-scale basis. Some western Canadian major municipalities such as Regina and Calgary extensively use water softeners as the local water carries high calcium and magnesium concentrations. Over the last five years, the market has grown rapidly; this expansion is expected to continue in 1990 at an annual growth rate of 4%. Reduced economic growth expected in Canada during 1990 may hinder a more significant increase since new users' volumes are associated with housing starts; however, increasing concerns over the quality of drinkable water and surface water pollution could spur the demand for water softeners.

New usages for salt which could emerge in the next decade may involve its role as a catalyst in flue gas desulphurization, as a dust control agent in coal mines and as an additive in the solution mining of copper sulphides. The utilization of rock salt beds for underground storage is also expanding for toxic and radioactive waste materials; the US$700 million Waste Isolation Pilot Plant in New Mexico, U.S.A. is a prime example for establishing a permanent underground storage site for low-level radioactive wastes. This facility may open in 1990.

TRADE

In 1988, salt imports increased 16% to 1.27 Mt; the average unit value for imported salt decreased 14% to $18.52/t. Exports jumped 60% to 3.0 Mt, a record for the past decade. These 1988 exports were valued at $47.6 million. During the first nine months in 1989, imports amounted to 1.67 Mt, an 80% increase over 1988, which was primarily due to larger import volumes from the United States into central Canada. Imports were mainly from the United States (78%), Mexico (14%) and Chile (5%) for deliveries in Ontario (41%), Quebec (28%) and British Columbia (27%). Nine-month exports in 1989 declined 26% to 1.49 Mt, valued at $26 247 000. Exports were shipped to about twenty countries, but the bulk was for the United States which accounted for 99.8%. Deliveries were shipped mainly through Ontario (88%), with the remainder coming from Quebec, New Brunswick and British Columbia. The unit value of exports averaged $17.55/t, a 19% increase over the same period in 1988.

WORLD PRODUCTION AND REVIEW

In 1988, world production rose 4% to 185 Mt. Although salt was produced in over 110 countries, production was dominated by the United States which accounted for 19%, followed by China (12%), the U.S.S.R. (8%) and West Germany (7%). Canada ranked fifth with 6%. In the last six years, world salt output increased 7.7%, with major augmentations in China and Western Europe. World salt consumption was estimated at 184 Mt of which the manufacture of chemicals contributed to 60%. The second largest use for salt was in food processing with 19%, of which two thirds was consumed in India. Consumption for road de-icing occurred mainly in North America and Western Europe, accounting for about 10%. The remaining 11% was used in industrial processes.

United States

In 1989, salt production was estimated at 35.7 Mt, valued at US$699 million. Thirty-one companies operated 67 plants in 15 states. At year-end 1988, the annual salt production capacity was reported at 39.8 Mt; salt producers operated at a rate of 90% of capacity during 1989. Apparent consumption reached 38.8 Mt, a 1.7% decline from 1988. Brine sales accounted for half of the salt sold or used, followed by rock salt (33%), evaporated salt (10%) and solar salt (7%). The chloralkalies industry consumed 48% of the total salt sold. As a result of strong demand for caustic soda and chlorine, this industry operated at 96.3% of effective capacity in 1989. Road and ice control accounted for 26%, a small increase over 1988. The average unit value for rock salt shipment rose 11% to US$16.00/t. Imports decreased 9% to 4.5 Mt and were mainly from Canada, Mexico and the Bahamas. The net import reliance was estimated at 8% of apparent consumption. Exports rose 47% to 1.2 Mt, mostly shipped to Canada.

G. Harris and Associates, an investment group in the United States, purchased the assets of Carey Salt Co. from Processed Minerals Inc., after it had acquired American Salt Company. During 1989, the group bid for acquiring the North American operations of Sifto Salt, a division of Domtar Inc. of Canada. The purchase involved one major underground mine in Goderich, Ontario; three evaporated plants in Nappan (New Brunswick), Goderich (Ontario) and Unity (Saskatchewan); and one large underground mine in Baldwin, Louisiana. The acquisition was approved by Investment Canada late in 1989 but is pending a final approbation from the U.S. Department of Justice by early 1990. The group will become the third largest producer of salt in North America with a total capacity of 7.4 Mt/y. This latest development confirmed the current trend for rationalization prevailing in North America whereas the willingness for further industry concentration and better productivity led to a series of modernizations and acquisitions within the last five years.

Japan

Japan is the 20th world producer of salt and the world's largest importer, contributing to one third of world trade. In 1988, Japan produced 1.36 Mt of salt. Imports amounted to 7.5 Mt from Australia (56%) and Mexico (44%). Although China was a predominant supplier in the 1980s, this trade was phased out in 1988. Consumption of salt in 1988 was estimated at 8.8 Mt of which 60% was for chloralkalies; 19% for sodium carbonate, 12% for food processing and the balance for general industry, household usage and road de-icing.

In Poland, the 700-year-old solution mining operation at Bochnia was shut down and replaced by a new 600 000 t/y salt brining facility at Maszczenia. In Yugoslavia, construction work at the second shaft of the new Tetima salt mine on Mount Majevica near Tuzla was completed. A total of seven shafts is planned for this 800 000 t/y mine to be completed in 1992. Discovered in 1984, total reserves of salt at this deposit were estimated at around 400 Mt.

INTERNATIONAL TRADE

Salt is a widespread, low value, bulk commodity. It is relatively easy to extract and transportation represents a significant proportion of the total delivered price of salt. Consequently, international trade in salt is small relative to world production, i.e., about 20% of total world production. Trade in the Pacific area will account for one half of the seaborne movements by 1991, followed by North America (24%) and northwestern Europe (20%). Australia is expected to remain the major supplier to Japan while Mexico will continue to export mainly to Japan and North America. The European Economic Community is forecast to remain essentially self-sufficient with very minor imports from non-members.

PRICE

The price of salt depends on factors such as production methods, purity, scale of operations and transportation costs.

In 1989, prices for de-icing rock salt, bulk f.o.b. works, rose 2-4% and varied between $44-79/t. Prices in Atlantic Canada were in the $42-44/t range, in Quebec $58-79/t, and in Ontario $44-48/t. Prices for agricultural salt products rose 2.5% on average; a 25 kg lick block cost around $5-7. Fine evaporated salt prices increased 2-3% and varied between $96-131/t. Water conditioning grades were sold for $7-9 per 40 kg bag, a 4% increase over 1988.

Over the last five years, prices for salt products have risen slightly at a pace below the annual inflation rate; the availability and the nature of salt trade restrain any significant price increases in the rock salt market. However, some gains are usually registered in value-added products such as high-grade evaporated salt, table salt and water conditioner salt pellets or nuggets. Salt prices in 1990 are expected to follow this trend and are forecast to increase by 4-5%.

OUTLOOK

Canada's capacity of salt production is likely to be sufficient to meet its domestic requirements and export demand over the next decade. The domestic consumption is forecast to increase slightly in 1990 due to sustained demand in the chloralkalies sector and to supporting weather conditions that prevailed early in the winter of 1989-90. Consumption of de-icing salt is projected to show a modest growth compared to the excellent previous year due to a higher consumption rate in urban areas. However, mounting pressures related to corrosion concerns will favour the use of salt de-icer alternatives in selected corrosion-sensitive areas such as bridge decks and parking lots.

The manufacture of inorganic chemicals will remain a major market for salt in spite of all the concerns over the environment. In 1990, salt consumption in chemicals is forecast to be flat due to expectations for a weaker economy and lower operating rates in the pulp and paper sector. The demand for chlorine is expected to grow at an annual rate of 0-1.5% for the next three years. The growth is largely attributed to a sustained performance in the vinyl industry. The consumption of chlorine in the pulp and paper sector is projected to decline by 25-50% over the next three to four years, essentially due to the controversy over the presence of dioxin in pulp mill effluents and paper products. Other environmental concerns may dampen its growth in the future: the disposal of hydrochloric acid wastes from ethylene dichloride manufacture, and the depletion of the atmospheric ozone layer due to chlorofluorocarbons. The production of polyvinyl chloride (PVC), vinyl chloride monomer and ethylene dichloride is expected to increase at a moderate annual rate of 1-1.5% through the decade.

Meanwhile, the demand for chlorine's coproduct, caustic soda or sodium hydroxide, is forecast to be strong in the pulp and paper sector. Consumption of caustic soda is projected to increase 2-3%/y up to 1994. As its requirement will outpace that for chlorine, the market for caustic soda will likely be facing potential shortages and price increases by 1990. Alternatives for caustic soda, such as sodium carbonate, will be in demand.

The accelerating substitution of chlorine by chlorine dioxide in pulp bleaching is triggering a favourable market for sodium chlorate. In North America, the consumption of sodium chlorate is forecast to increase 15% by 1994. Several expansions were announced in Canada, and the capacity of production for sodium chlorate will reach 960 000 t/y by 1992, a 65% increase over 1989. Most of these increases will take place in western Canada and Quebec. Overall, chloralkalies plants in Canada are expected to operate at 90% of capacity for the 1990-91 period due to reduced demand for chlorine.

The demand for salt in water treatment will continue to be strong for at least the next two years. The annual growth rate is projected at 2-3% due to increasing concerns over drinking water quality.

The world's consumption of salt is expected to increase at an annual growth rate of 2% to reach 227 Mt by the year 2000.

Note: Information contained in this review was current as of mid-January 1990.

TARIFFS

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
2501.00	Salt (including table salt and denatured salt) and pure sodium chloride, whether or not in aqueous solution; sea water				
2501.00.10	--- Table salt made by an admixture of other ingredients when containing 90% or more of pure sodium chloride	4%	2.5%	Free	Free
2501.00.90	--- Other	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, SALT SHIPMENTS AND TRADE, 1988 AND 1989

	1988		1989p	
	(tonnes)	($000)	(tonnes)	($000)
Shipments				
By type				
Mined rock salt	7 126 762	150 546	7 804 537	171 403
Fine vacuum salt	783 368	75 708	807 865	77 743
Salt content of brines used or shipped	2 777 050	20 468	2 737 421	20 163
Total	10 687 180	246 722	11 349 823	270 179
By province				
Nova Scotia	x	x	x	x
New Brunswick	x	x	x	x
Quebec	x	x	x	x
Ontario	6 599 080	154 642	7 381 667	180 047
Saskatchewan	409 615	24 099	418 193	24 170
Alberta	1 256 109	15 865	1 411 826	16 240
Total	10 687 180	246 722	11 349 823	270 179
Imports			(Jan.-Sept.)	
2501.00 Salt[1]				
United States	829 719	18 400	1 317 933	23 213
Mexico	309 088	3 313	227 442	2 105
Chile	73 850	730	76 800	721
Spain	39 797	676	22 550	423
Bahamas	20 337	342	19 230	375
Other countries	3 893	224	7 793	287
Total	1 276 684	23 685	1 671 748	27 124
By province of clearance				
Newfoundland	48 309	814	39 726	722
Prince Edward Island	-	-	30	1
Nova Scotia	12 563	205	7 828	208
New Brunswick	85	15	8	-
Quebec	220 167	2 652	464 392	6 784
Ontario	416 623	10 349	685 960	12 621
Manitoba	10 370	316	5 533	128
Saskatchewan	24 045	856	1 206	86
Alberta	13 268	577	16 821	595
British Colombia	530 654	7 901	450 244	5 979
Total	1 276 684	23 685	1 671 748	27 124
Exports				
2501.00 Salt[1]				
United States	3 025 529	47 081	1 492 170	25 819
St. Pierre and Miquelon	1 333	80	864	78
Puerto Rico	674	113	314	53
Other countries	2 188	298	1 606	297
Total	3 029 724	47 572	1 494 954	26 247

Sources: Statistics Canada; Energy Mines and Resources Canada.
[1] Includes table salt, pure sodium chloride and seawater salt.
p Preliminary; x Confidential; - Nil or not reported.
Note: Totals may not add due to rounding.

TABLE 2. CANADA, SUMMARY OF SALT–PRODUCING AND BRINING OPERATIONS, 1987 AND 1988

Company	Location (Initial Production)	Annual Production Capacity	Production 1988[p] (1987)	Employment 1988[p] (1987)	Remarks
		(000 tonnes)			
Nova Scotia					
The Canadian Salt Company Limited	Pugwash (1959)	1 200	759.3 (925.0)	196[1] (184)	Rock salt mining to a depth of 305 m
	Pugwash (1962)	110	78.5 (84.1)		Dissolving rock salt fines for vacuum pan evaporation
Domtar Inc.	Nappan (1947)	100	95.4 (68.6)	80 (80)	Brining for vacuum pan evaporation
New Brunswick					
Potash Company of America	Sussex (1980)	450	443.5 (385.1)	32 [2] (32)	By–product rock salt from potash mine for use in snow and ice control
Quebec					
Seleine Mines Divison of The Canadian Salt Company Limited	Îles–de–la–Madeleine (1982)	1 200	1 196.5 (1 099.7)	183 (203)	Rock salt mining to a depth of up to 273 m.
Ontario					
General Chemical Canada Ltd.	Amherstburg (1919)	630	688.3 (650.3)[r]	8 [2] (8)	Brining to produce sodium carbonate
The Canadian Salt Company Limited	Ojibway (1955)	2 500	2 220.0 (1 702.4)	216 (215)	Rock salt mining at a depth of 300 m
	Windsor (1892)	150	140.7 (137.5)	129 (90)	Brining, vacuum pan evaporation
Domtar Inc.	Goderich (1959)	2 800	2 626.1 (2 410.8)	335 (335)	Rock salt mining at a depth of 536 m
	Goderich (1880)	120	101.3 (108.9)	70 (70)	brining for vacuum pan evaporation
Dow Chemical Canada Inc.	Sarnia (1950)	900	902.0 (829.8)	4 [2] (4)	Brining to produce caustic soda and chlorine.
Prairie Provinces					
International Minerals & Chemical Corporation (Canada) Limited (IMCC)	Esterhazy, Sask. (1962)	120	106.8 (105.2)	3 (3)	By–product rock salt from potash mine for use in snow and ice control
The Canadian Salt Company Limited	Belle-Plaine, Sask. (1969)	170	105.1 (116.7)	29 (30)	Producing fine salt from by–product brine from nearby potash operation.
Domtar Inc.	Unity, Sask. (1949)	180	153.5 (157.3)	85 (85)	Brining, vacuum pan evaporation and fusion
Saskatoon Chemicals	Saskatoon, Sask. (1968)	70	68.1 (67.7)	5 [2] (5)	Brining to produce caustic soda, chlorine and sodium chlorate.
The Canadian Salt Company Limited	Lindbergh, Alta. (1968)	140	136.6 (149.9)	68 (70)	Brining, vacuum pan evaporation
Dow Chemical Canada Inc.	Fort Sask., Alta. (1968)	1 400	1 070.3 (1 083.4)	3 [2] (3)	Brining to produce caustic soda and chlorine.
		12 300	10 895.0 (10 109.2)[r]	1 466 (1 417)	

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada, 1989; Company surveys.

[1] Includes employment in brining operation at Pugwash. [2] Employment part of chemical complex.

[p] Preliminary; [r] Revised.

TABLE 3. CANADA, SALT SHIPMENTS AND TRADE, 1980-89

	Producers' Shipments					
	Mined Rock	Fine Vacuum	In Brine and Recovered in Chemical Operations	Total	Imports	Exports
			(tonnes)			
1980	4 507 416	781 428	2 134 010	7 422 854	1 151 203	1 637 601
1981	4 371 314	764 037	2 107 243	7 242 594	1 254 992	1 507 710
1982	5 223 073	773 086	1 944 172	7 940 331	1 526 879	1 721 893
1983	5 846 994	714 464	2 040 925	8 602 383	814 250	1 914 629
1984	7 030 664	754 675	2 450 060	10 235 399	1 053 217	2 530 038
1985	6 608 739	805 209	2 670 749	10 084 697	1 255 518	2 263 076
1986	6 867 287	815 044	2 649 515	10 331 846	1 328 298	2 502 518
1987	6 670 863	866 475	2 591 715	10 129 053	1 112 102	2 502 518
1988	7 126 762	783 368	2 777 050	10 687 180	1 276 684	1 924 686
1989p	7 804 537	807 865	2 737 421	11 349 823	n.a.	n.a.

Sources: Statistics Canada; Energy, Mines and Resources Canada.
p Preliminary; n.a. Not available.

TABLE 4. CANADA, SALT PRODUCTION CAPACITY BY PLANT, 1984-89

Company and Location	Type of Salt	1984	1985	1986	1987	1988	1989
				(000 t y)			
Canadian Salt Company Limited, The							
Pugwash, Nova Scotia	RS	1 100	1 200	1 200	1 200	1 200	1 200
Pugwash, Nova Scotia	ES	100	110	110	110	110	110
Seleine, Quebec	RS	1 200	1 200	1 200	1 200	1 200	1 500
Ojibway, Ontario	RS	2 000	2 500	2 500	2 500	2 500	2 500
Windsor, Ontario	ES	150	150	150	150	150	150
Belle-Plaine, Saskatchewan	BES	160	170	170	170	170	170
Lindberg, Alberta	ES	140	140	140	140	140	140
Domtar Inc.							
Nappan, Nova Scotia	ES	90	90	100	100	100	100
Goderich, Ontario	RS	2 800	2 800	2 800	2 800	2 800	2 800
Goderich, Ontario	ES	115	120	120	120	120	120
Unity, Saskatchewan	ES	175	180	180	180	180	180
Dow Chemical							
Sarnia, Ontario	SB	760	790	800	830	900	900
Fort Saskatchewan, Alberta	SB	1 140	1 250	1 400	1 400	1 400	1 400
General Chemical							
Amherstburg, Ontario	SB	620	620	620	650	690	690
PCA							
Sussex, New Brunswick	BRS	400	500	500	500	450	450
IMCC							
Esterhazy, Saskatchewan	BRS	120	120	120	120	120	120
Saskatoon Chemicals							
Saskatoon, Saskatchewan	SB	70	70	70	70	70	70
Total Canada		11 140	12 010	12 180	12 240	12 300	12 600

Source: Mineral Policy Sector, Energy, Mines and Resources Canada.
RS Rock salt; BRS By-product rock salt from potash operations; ES Evaporated salt; BES Evaporated salt processed from salt brine recovered from potash operations; SB Salt brines.

TABLE 5. CANADIAN CHEMICAL PLANTS USING SALT AS A MAJOR RAW MATERIAL: DEVELOPMENTS AND PROJECTS IN 1989

Company	Location	Parent Company	Plant Location	Type of Cells	Products	Annual Capacity[1]	Remarks
						(tonnes)	
Albright & Wilson Americas Inc.	Islington, Ontario	Tenneco, Inc., Texas, U.S.A.	Buckingham, Quebec	metal	sodium chlorate	78 000	A further 44 000 t/y expansion is planned for mid-1991.
			Grande Prairie, Alberta	metal	sodium chlorate	45 000	A new grass-roots operation is planned for completion in the spring of 1992.
			Thunder Bay, Ontario	metal	sodium chlorate	53 000	A 5 000 t/y expansion completed in mid-1989.
			North Vancouver, British Columbia	metal	sodium chlorate	77 500	A 60 000 t/y expansion is planned by mid-1991. Ultimately graphite cells will be eliminated.
Alby Chlorate Canada Inc.	Valleyfield, Quebec	Alby Klorat AB, Sweden; Olin Corp., U.S.A.	Valleyfield, Quebec	metal	sodium chlorate	50 000	Expansion announced in 1988 will increase the capacity to 110 000 t/y by April 1990.
B.C. Chemicals Ltd.	Prince George, British Columbia	B.C. Chemicals Ltd., Prince George, B.C.	Prince George, British Columbia	metal	sodium chlorate	34 000	The company announced plans to expand its capacity to 77 000 t/y by 1991.
Canadian Occidental Petroleum Ltd.	Calgary, Alberta	Occidental Petroleum Corporation, Los Angeles, CA, U.S.A.	Amherstburg, Ontario	metal	sodium chlorate	50 000	Bought from BCM Technologies Inc. in 1988.
			Brandon, Manitoba	metal	sodium chlorate	43 000	A multi-stage expansion is to be completed by the end of 1990, increasing capacity to 85 000 t/y.
			Bruderheim, Alberta	metal	sodium chlorate	50 000	A new $60 million plant was announced to be completed late in 1991.
			Nanaimo, British Columbia	metal	sodium chlorate	8 000	A $27 million expansion of 8 000 t/y is to be completed by mid-1990.
				diaphragm	caustic soda chlorine	31 000 28 000	

			North Vancouver, British Columbia	diaphragm	caustic soda chlorine	155 000 141 000	
			Squamish, British Columbia	metal	sodium chlorate	11 000	
			Squamish, British Columbia	mercury	caustic soda chlorine	75 000 68 000	
Canso Chemicals Limited	Abercrombie Point, Nova Scotia	C-I-L Inc., North York, Ontario	Abercrombie Point, Nova Scotia	mercury	caustic soda chlorine	20 000 18 000	
C-I-L Inc	Willowdale, Ontario	Imperial Chemical Industries plc (ICI), England	Becancour, Quebec	diaphragm	caustic soda chlorine	325 000 295 000	
			Cornwall, Ontario	mercury	caustic soda chlorine	38 500 35 000	
			Dalhousie, New Brunswick	mercury	caustic soda chlorine	31 000 28 000	
Dow Chemical Canada Inc.	Sarnia, Ontario	The Dow Chemical Company, Michigan, U.S.A.	Fort Saskatchewan, Alberta	diaphragm	caustic soda chlorine	524 000 476 000	Closed its dry anhydrous and purified caustic soda capacity in 1989.
			Sarnia, Ontario	diaphragm	caustic soda chlorine	350 000 318 000	
General Chemical Canada Ltd.	Amherstburg, Ontario	General Chemical Corporation, Morristown, New Jersey, U.S.A.	Amherstburg, Ontario	metal	calcium chloride sodium carbonate	317 500 362 800	
Great Lakes Forest Products Limited	Thunder Bay, Ontario	Canadian Pacific Securities Limited Montreal, Quebec	Dryden, Ontario	membrane	caustic soda chlorine	16 000 14 500	
PPG Canada Inc. Industrial Chemical Division	Beauharnois, Quebec	PPG Industries, Inc. Pittsburg, Penn., U.S.A.	Beauharnois, Quebec	metal	sodium chlorate	40 000	
				mercury	caustic soda chlorine	67 000 61 000	Announced the replacement of its mercury cells by membrane cells by the end of 1990, increasing its capacity by 20%.

TABLE 5. (cont'd)

Company	Location	Parent Company	Plant Location	Type of Cells	Products	Annual Capacity^r	Remarks
						(tonnes)	
QueNord Inc.	Magog, Quebec	Kema-Nobel AB, Sweden	Magog, Quebec	metal	sodium chlorate	107 000	A 15 000 t/y de-bottlenecking project was completed in 1989.
St. Anne Chemicals Co. Ltd.	Nackawic, New Brunswick	Parsons & Whittemore, Inc. New York, U.S.A.	Nackawic, New Brunswick	metal	sodium chlorate	9 000	Captive production.
				membrane	caustic soda chlorine	10 000 9 000	Captive production.
Saskatoon Chemicals	Saskatoon, Saskatchewan	Weyerhaeuser Canada Ltd. Kamloops, B.C.	Saskatoon, Saskatchewan	metal	sodium chlorate	22 000	The company announced a $17.8 million project to increase capacity to 44 000 t/y. Completion due in 1990.
				membrane	caustic soda chlorine	36 000 33 000	

Sources: Mineral Policy Sector, Energy, Mines and Resources Canada; Chemicals Directorate and Investments, Department of Industry, Science and Technology Canada (Ottawa); December 1989.

^r Revised.

TABLE 6. WORLD SALT PRODUCTION, 1984–88

Countries	1984	1985	1986[r]	1987[p]	1988[e]
			(000 tonnes)		
United States	35 580	36 370	33 250	33 100	35 310
China[e]	16 280	14 440	17 300	19 960	22 000
U.S.S.R.[e]	16 510	16 100	15 300	15 400	15 500
West Germany	12 210	13 070	13 100	13 460	13 600
Canada	10 310	10 000	10 330	10 125	10 690
India	7 720	9 870	10 110	9 900	8 400
France	7 150	7 110	7 080	7 840	7 910
United Kingdom	7 130	7 140	7 070	7 075	7 070
Mexico	6 160	6 470	6 200	6 200	6 960
Australia	5 700	6 170	6 130	6 485	6 500
Poland	4 710	4 860	5 420	6 165	5 700
Romania	4 870	5 020	5 355	5 400	5 400
Italy	3 980	3 750	4 230	4 490	4 500
Other	34 160	33 355	34 295	37 525	35 395
Total	172 470	173 725	175 170	178 640	184 935

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, 1988.
[p] Preliminary; [e] Estimated; [r] Revised.

Silica

1989

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SUMMARY

Preliminary figures indicate that in 1989 silica production shipments in Canada were 2 634 500 t; this compares with 2 806 775 t in 1988. Shipments decreased mainly in Ontario, Manitoba and Quebec.

The consumption of silica sand by the glass container industry, which is the largest consumer of high-quality silica, continued to be affected negatively by the use of recycled glass waste and the use of lighter glass in vehicle construction. Competition from aluminum, paper and plastics also continued to erode markets traditionally belonging to glass containers. For these reasons, Consumers Glass, a division of Consumers Packaging Inc., closed its plants at Redcliff, Alberta and Ville St-Pierre near Montreal, Quebec.

The closure of Tenneco Canada Inc. in Newfoundland, a producer of elemental phosphorus that uses silica in its process, will result in the permanent closure of Dunville Mining Company Limited, also located in Newfoundland, during the summer of 1990.

Markets for the flat glass industry were slow due to a lower level of activity in general in Canada, a high Canadian dollar and high interest rates affecting car sales and the construction industry.

Demand for silicon carbide and foundry sand fared well as iron and steel output continued its growth in North America.

Insulating fiberglass fared well in eastern Canada, but poorly in western Canada where Fiberglas Canada Inc. had to close its plant permanently at Mission, British Columbia.

Fiberglas Canada Inc. of Guelph, Ontario shut off some of its furnaces during the year as a result of weak demand for reinforcing fiberglass.

The sandblast industry continued to suffer from environmental pressures related to health hazards and competition from products such as olivine and garnet.

Finally, the strong Canadian dollar resulted in tougher competition and downward price pressures for the producers of silica in Canada.

SUPPLY

Newfoundland

All silica production from Dunville Mining Company Limited, a subsidiary of Tenneco Canada Inc., is captive to Tenneco, a producer of elemental phosphorus, where silica is used as a flux. The quartzite quarry at Villa Marie operates from May to December and produces silica grading close to 95% SiO_2. The ore is shipped to Tenneco's Long Harbour phosphorus plant which was permanently closed in August 1989. As a result, Dunville will close its silica operation during the summer of 1990.

Nova Scotia

Nova Scotia Sand and Gravel Limited produces a high-purity silica from sand deposits, for a variety of uses such as sandblasting, glass, foundry sand and fracturing sand. The mine is located near Shubenacadie.

New Brunswick

Chaleur Silica Ltd. produces silica for use as a flux in Brunswick Mining and Smelting Corporation Limited's Belledune lead smelter for cement plants and as sandblasting material.

Sussex Silica Inc. mines a high-grade (+98% SiO_2) silica deposit near Sussex. The company produces lump silica and sand of various sizes. Lump silica and coarse-grained sand are used in the manufacture of silicon metal and silicon carbide in Quebec. The fine sand is used in sandblasting, as filter sand and decorative sand in the Maritimes, and as a flux for base metal smelters.

Quebec

Falconbridge Limited is the largest producer (in terms of volume and value of production) of silica east of Ontario. Silica is mined from a quartzite deposit at Saint Donat and from a sandstone deposit at Saint Canut. Silica from Saint Donat (capacity: 100 000 t/y) is refined at the Saint Canut plant near Montreal. Most silica produced by Falconbridge originates from Saint Canut where the ore is crushed, screened and beneficiated by attrition scrubbing, flotation and magnetic separation. Production capacity of the Saint Canut plant is about 650 000 t/y of finished products. The major markets for Falconbridge products are the glass, fiberglass and silicon carbide industries.

Uniquartz Inc. mines a silica-rich sandstone deposit near St. Jean Vianney, about 30 km from Matane. The deposit is reported to contain more than 25 Mt of high-purity ore. Some 60 000 t/y of lump ore are sold to European consumers for the production of ferroalloys. A concentrator is expected to be built in late 1990 for the production of higher purity silica. Eventually, the company intends to produce some 200 000 t/y of high-purity silica sand for use by the flat glass and foundry industries in Canada and western Europe.

Hogan Holdings Inc., (formerly Baskatong Quartz Inc.), produces lump high-purity silica from a quartzite deposit north of Saint Urbain. The silica is used mainly by SKW Canada Inc. at Bécancour for the production of ferrosilicon and silicon metal, and also by Elkem Métal Canada Inc. at Chicoutimi. Baskatong also produces high-purity silica from quartz vein deposits located at Lac Bouchette south of Lac Saint-Jean. This silica is sold almost exclusively to SKW for the production of ferrosilicon.

Loma Enterprises Ltd. of Beauport crushes and classifies the fines produced by SKW Canada Inc. for sale to the silicon carbide and sandblast industries.

Armand Sicotte & Sons Limited mines Potsdam sandstone at Sainte Clothilde, south of Montreal. Lump silica is used for the production of ferrosilicon, phosphorus and cement.

The Good Sand Company Ltd. mines silica sand and gravel at St. Joseph-du-Lac and at Ormstown. The material is used mainly for sandblasting, but also for fiberglass and foundries.

Temisca Exploration Inc. of St. Bruno-de-Guigues produces silica on a small scale for use in sylviculture, filtration, sandblast, foundries and as traction sand. The company plans to build a new plant in 1990 that would increase production to some 50 000 t/y.

During the year, Glaverbec Inc., started the construction of a 500 t/d flat glass plant near Quebec City. When production starts in mid-1990, the plant is expected to consume approximately 100 000 t/y of silica.

Ontario

Falconbridge Limited is the largest producer (in terms of volume and value of production) of silica west of Quebec, with a reported total capacity of about 550 000 t/y. Lump quartzite from Badgeley Island (capacity 150 000 t/y), north of Georgian Bay, is shipped by lake boat to Canadian destinations for the manufacture of ferrosilicon. The finer material produced by crushing, is shipped to Midland (capacity 400 000 t/y), south of Georgian Bay, where it is further processed to a glass-grade silica sand and silica flour for ceramic and other uses.

Manitoba

Marine Transport Limited of Selkirk, produces high-purity silica sand from a quarry on Black Island on Lake Winnipeg, some 130 km north of Selkirk. The silica sand, mined from a poorly consolidated white sandstone, is well rounded and suitable for use in foundries, glass, fiberglass, construction and as traction sand. The ore is washed, screened and dewatered at a plant on the island, and then shipped by barge to a processing plant at Selkirk on the Red River. The closure of Consumers Glass plant at Redcliff, Alberta will result in a loss of sales of about 30 000 t/y.

Inco Limited produces, from the Manasan quarry, a low-grade silica from an impure quartzite for its Thompson smelter and converter. Production varies from year to year, depending on nickel production.

Saskatchewan

Hudson Bay Mining and Smelting Co., Limited (HBMS) produces smelter flux from two pits in the Amisk Lake area of northern Saskatchewan. The silica sand is used by Hudson Bay Mining at its Cu-Zn smelter in Flin Flon, Manitoba.

Alberta

Sil Silica, a division of Clarepine Industries Inc., produces silica sand from local sand dunes in the Bruderheim area. Silica is sold mainly as fiberglass and sandblasting material. It is also sold as foundry sand, filtration sand, fracturing sand and as railway traction sand.

British Columbia

Mountain Minerals Co. Ltd. mines a high-purity, friable sandstone deposit near Golden. Rock is crushed, screened, washed, dried and separated into several sizes. These different sizes are sold for glass sand, sandblasting sand, foundry sand, filter media sand, golf course sand and fine sand.

TRADE

Most silica sand imported into Canada comes from loosely consolidated and easily processed sandstone or lake sand deposits located near the Great Lakes region of the United States in Illinois, Wisconsin, Michigan and Indiana. The imported silica sand is used mainly by iron and steel foundries and by the glass industry of Ontario and Quebec.

OUTLOOK

Little improvement is expected in 1990 in Canada in the container glass industry. However, in the longer term, environmental concerns and the disposal problems posed by the plastics containers should encourage a greater use of glass containers which are easier to recycle.

Markets for the flat glass and fiberglass industries are not expected to improve as long as interest rates and the Canadian dollar remain high. In the long term, competition from U.S. producers of silica for glass and foundry sand will remain strong in Ontario and Quebec because of the proximity of these provinces to the low-cost producers of the Great Lakes region in the United States. Also due to the down-sizing of passenger cars and the recycling of silica sand at foundries, no growth can be expected in the foundry sand industry in Canada. Competition from substitutes for glass containers such as paper, plastics and aluminum will remain strong across Canada. Sandblast will continue to decline as a result of tighter environmental controls and substitution. The filler market is still very small, but its growth will continue to be strong.

OPPORTUNITIES

Higher value silica products could be produced in Canada because of the low cost of electricity in certain parts of the country. Such products include:

a) cultured quartz for the production of oscillators used in the electronics industry;
b) raw vitreous silica (minimum 99.8% SiO_2) and manufactured products of vitreous silica for the chemical industry, etc.;
c) refined silicon carbide for advanced ceramics;
d) monocrystalline silicon for the production of silicon chips; and
e) high-purity ground silica (minimum 99.5% SiO_2; 2 to 20 microns) for use as an abrasive for metal polishes, cleansers, fillers in plastics, rubber, etc.

None of these products are yet manufactured in Canada.

Also, there are potential opportunities for:

f) a new flat glass plant;
g) an integrated silicon carbide plant in western Canada, based on local raw materials and inexpensive electricity;
h) a new reinforcement fiberglass plant (in Canada there is only one plant in Ontario);
i) the production of silicones[1] by reacting silicon metal powder with methyl chloride;
j) fumed silica[1] from the hydrolysis of silicon tetrachloride[2] in a flame of hydrogen and oxygen for use as a thickening agent in inks, paints, cosmetics, rubber, etc.; specialty coatings such as powder coatings, etc.;
k) sodium silicate by reacting silica with sodium hydroxide or sodium carbonate, for use in detergents, foundries, refractory cements, etc. (in Canada there is one producer in Quebec, one in Ontario, and one in Alberta); and
l) precipitated silica and silica gel[1] by reacting sodium silicate with sulphuric acid (the products are used for reinforcing rubber, extender in paints, fillers in inks, thickening and polishing agent in toothpastes, etc.)

PRICES

The unit value of shipments of silica in Canada was $16.33/t in 1989. This compares with $16.55/t in 1988.

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[1] No production facility yet exists in Canada, although most raw materials are available.
[2] Produced through the chlorination of silicon metal or silica.

Note: Information contained in this review was current as of mid-January 1990.

TABLE 1. CANADA, SILICA PRODUCTION AND TRADE, 1988 AND 1989

		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production (shipments)					
Newfoundland		x	x	x	x
Nova Scotia		x	x	x	x
New Brunswick		x	x	x	x
Quebec		941 325	18 771	912 000	18 894
Ontario		1 005 979	12 365	894 814	9 603
Manitoba		256 346	3 036	207 170	1 648
Saskatchewan		164 250	x	159 500	x
Alberta		x	4 423	x	5 200
British Columbia		144 111	2 462	142 000	2 974
Total		2 806 775	46 439	2 634 484	43 014
Imports[1]				**(Jan.-Sept.)**	
2505.10	Silica sands and quartz sands				
	United States	910 292	20 505	453 177	11 954
	West Germany	198	117	78	42
	Belgium	54	32	72	38
	Other countries	-	-	62	41
	Total	910 545	20 656	453 390	12 078
2506.10	Quartz (other than natural sands)				
	United States	7 987	456	3 713	261
	Japan	208	11	-	-
	Brazil	125	6	923	68
	Total	8 320	475	4 636	330
2506.21	Quartzite crude or roughly trimmed				
	United States	716	95	1 192	109
	Sweden	162	32	-	-
	Total	878	128	1 192	109
2506.29	Quartzite n.e.s.				
	United States	1 175	106	1 981	168
	Brazil	161	4	39	5
	Total	1 336	111	2 020	174
2811.22	Silicon dioxide				
	United States	18 303	17 689	7 371	13 081
	West Germany	1 842	3 990	1 120	3 678
	Other countries	967	745	616	867
	Total	21 112	22 425	9 107	17 628
Exports					
2505.10	Silica sands and quartz sands				
	United States	11 209	287	7 801	535
	Cuba	4 393	126	-	-
	Other countries	358	118	270	70
	Total	15 962	535	8 071	608

TABLE 1. (cont'd)

		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
2506.10	Quartz (other than natural sands)				
	United States	47 962	286	4 627	25
	Other countries	1 511	92	75	3
	Total	49 473	380	4 702	29
2506.21	Quartzite, crude or roughly trimmed				
	United States	4 418	22	24 854	121
	Total	4 418	22	24 854	121
2506.29	Quartzite n.e.s.				
	United States	48 220	180	5 400	65
	Sweden	40	1	-	-
	Total	48 260	182	5 400	65
2811.22	Silicon dioxide				
	United States	379	157	90	63
	West Germany	143	39	-	-
	Other countries	61	44	9	25
	Total	584	241	99	89

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Includes sand for use in foundries and glass manufacturing, ground and flour sand, volatized and silica flue dust.

p Preliminary; x Confidential; n.e.s. Not elsewhere specified; - Nil.

Note: Totals may not add due to rounding.

TABLE 2. IMPORTS OF SILICA SAND (FROM UNITED STATES) BY PROVINCE AND BY USE, 1988

	Foundry		Glass Manufacturing	
	(tonnes)	($000)	(tonnes)	($000)
Newfoundland	-	-	-	-
Nova Scotia	384	18	-	-
Prince Edward Island	-	-	-	-
New Brunswick	23	3	-	-
Quebec	17 824	687	9 595	127
Ontario	374 091	6 565	126 616	1 660
Manitoba	1 488	250	-	-
Saskatchewan	-	-	-	-
Alberta	387	28	-	-
British Columbia	11 415	1 004	3 948	167
Total	405 614	8 557	140 160	1 995

Sources: Statistics Canada; Energy, Mines and Resources Canada.
- Nil.
Note: Totals may not add due to rounding.

TABLE 3A. CANADA, SILICA PRODUCTION, TRADE AND CONSUMPTION, 1970, 1975, AND 1980-87

Year	Production Quartz and Silica Sand	Imports Silica Sand	Imports Silex or Crystallized Quartz	Exports Quartzite	Consumption[1] Quartz and Silica Sand
			(tonnes)		
1970	2 937 498	1 176 199	186	58 917	3 979 305
1975	2 491 715	1 044 160	1 550	39 977	3 510 818
1980	2 252 000	1 200 237	281	63 166	3 326 956
1981	2 238 000	1 142 880	251	119 347	3 079 225
1982	1 797 000	788 768	241	65 333	2 400 549
1983	2 303 451	982 662	271	103 960	2 792 580
1984	2 658 932	1 076 082	494	116 283	3 145 308
1985	2 668 650	983 340	341	112 762	3 109 667
1986	2 640 436	1 055 215	349	88 393	2 947 219[r]
1987	2 661 903	836 427	516	60 669	2 902 542[r]

Sources: Statistics Canada; Energy, Mines and Resources Canada.
[1] Available data, as reported by consumers.
[r] Revised.

TABLE 3B. CANADA, SILICA CONSUMPTION[1], 1987 AND 1988

	1987	1988p2
	(tonnes)	
Lump	781 420	1 001 994
Sand	2 077 244	2 094 940
Flour	43 878	60 916
Total	2 902 542	3 157 850

Source: Energy, Mines and Resources Canada.
[1] Available data, as reported by consumers. [2] Increase in number of establishments being surveyed.
p Preliminary.

TABLE 4. FLAT GLASS AND CONTAINER GLASS MANUFACTURING PLANTS IN CANADA

Company	Plant Location	Type of Glass
PPG Canada Inc.	Owen Sound, Ontario	Flat
AFG Glass Inc.	Scarborough, Ontario	Flat
Consumer Glass Company	Scoudouc, New Brunswick	Containers
	Montreal, Quebec	Containers
	Candiac, Quebec	Containers
	Etobicoke, Ontario	Containers
	Milton, Ontario	Containers
	Brampton, Ontario	Containers
	Hamilton, Ontario	Containers
	Lavington, British Columbia	Containers

TABLE 5. TYPICAL BATCH FORMULATIONS FOR FLAT GLASS, GLASS CONTAINERS AND FIBERGLASS

Raw Materials	Percent by Weight	Source of
Flat glass[1]		
Silica sand	60	SiO_2
High calcium limestone	4	CaO
Dolomitic limestone	15	MgO and CaO
Soda ash	20	Na_2O
Salt cake or gypsum	0.5	Na_2O CaO and SO_3
Rouge	0.5	Fe Colorant
Glass containers[2]		
Silica sand	60	SiO_2
Limestone	14-18	CaO,MgO
Soda ash	19	Na_2O
Alumina source (feldspar, nepheline syenite or aplite)	4–5	Al_2O_3,Na_2O,SiO_2
Others		
Gypsum and or barite	1	SO_3,BaO
Fiberglass		
Insulating fiber[3]		
Silica	40	SiO_2
Soda ash	10	Na_2O
Feldspar or nepheline syenite	20	Al_2O_3,Na_2O,SiO_2
Borax or ulexite	15	B_2O_3
Dolomite or limestone	15	MgO,CaO
Reinforcing fiber[4]		
Silica	28–30	SiO_2
Boric acid	8–11	B_2O_3
Colemanite	11–17	CaO,B_2O_3
Kaolin	26–28	Al_2O_3,SiO_2
Limestone or dolomite	28–31	CaO,MgO
Soda ash	0–1	Na_2O

Sources: [1] LOF Glass Company, Toledo, Ohio. [2] Brockway Inc., Brockway, Pennsylvania. [3] Fiberglas Canada Inc. [4] PPG Canada Inc.

TABLE 6. FIBERGLASS PLANTS IN CANADA

Company	Plant Location	Type of Fiber
Fiberglas Canada Inc.	Candiac, Quebec	Insulating
	Markham, Ontario	Insulating
	Sarnia, Ontario	Insulating
	Edmonton, Alberta	Insulating
Manson Insulation Inc.	Brossard, Quebec	Insulating
	Scarborough, Ontario	Insulating
Manville Canada Inc.	Innisfail, Alberta	Insulating
Graham Fiber Glass Limited	Erin, Ontario	Insulating
Ottawa Fiber Inc.	Ottawa, Ontario	Insulating
Fiberglas Canada Inc.	Guelph, Ontario	Reinforcing

Source: Falconbridge Limited.

TABLE 7. CANADA, REPORTED CONSUMPTION[1] OF SILICA, BY INDUSTRIES, 1987 AND 1988

	1987	1988[3]p
	(tonnes)	
Primary glass and glass containers, and glass fibre wool and glass fibre	924 700	865 614
Nonferrous smelting and refining	729 715	623 285
Foundries	427 523	414 382
Chemicals	197 715	211 197
Abrasives	120 516	131 236
Other products[2]	502 373	912 136
	2 902 542	3 157 850

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[1] Available data as reported by consumers. [2] Includes asbestos products, asphalt roofing products, cement, ceramic products, structural clay products, cleansers, fertilizers, paint and varnish, pulp and paper and products, refractory brick, rubber products, ferroalloys, primary steel and other miscellaneous products. [3] Increase in number of establishments being surveyed.
p Preliminary.

Silicon

1989

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SUMMARY

For the purpose of this review, silicon ferroalloys are defined as the three metallurgical grades of ferrosilicon (50% Si, 75% Si and 85% Si). Silicon metal and silicomanganese are the other silicon products reviewed.

Western world demand for silicon ferroalloys strengthened in 1987 and 1988, but declined in the latter half of 1989 due to reduced consumption in the production of iron and steel. Western world consumption in 1989 was estimated at 1.96 Mt of contained silicon. Canadian consumption was estimated at 83 500 t, an increase of 4% over consumption in 1988.

Production of silicon ferroalloys in the western world in 1989 was 2.1 Mt of contained silicon, a decrease of 4% compared to 1988 production. Canadian production of silicon ferroalloys was estimated at 88 370 t, a decrease of 2.1% relative to production in 1988. Nevertheless, the Canadian silicon ferroalloy industry continued to operate at near capacity throughout 1989. Canadian exports of silicon ferroalloys increased 2.4% in 1989 to 30 970 t, while imports rose by 23%, to 26 100 t, their highest level in the decade.

Western world demand for silicon metal increased in 1989 due to increased consumption estimated at 5.5% over the previous year.

World production of silicon metal in 1989 was estimated at 593 000 t, about 3% less than consumption in that year. This resulted in withdrawal of the metal from stocks accompanied by price increases in the first half of 1989.

Prices for 50% and 75% ferrosilicon in 1989 averaged about US$0.93/kg, 23% lower than in 1988. Prices for silicomanganese increased 30% in 1988 and a further 27% in 1989. Silicon metal prices increased an average of 4% in 1988 and 1989. The average price of silicon metal in 1989 was US$1.56/kg.

CANADIAN DEVELOPMENTS

Canada's three bulk silicon ferroalloy producers are all located in Quebec, and they used quartz mined in Quebec and Ontario to produce silicon ferroalloys and silicon metal. Elkem Métal Canada Inc., a subsidiary of Elkem a/s, and Timminco Limited, have bulk ferroalloy facilities located at Beauharnois. Elkem Métal also has a silicon ferroalloy facility located at Chicoutimi. Canada's other bulk ferroalloy producer, SKW Canada Inc., a subsidiary of SKW Trostberg AG, has its manufacturing facilities at Bécancour.

In 1989, Elkem Métal operated its silicon ferroalloy facility in Chicoutimi at capacity, and also operated its manganese furnace at Beauharnois at near capacity. The Beauharnois furnace, one of the largest in the western world, was alternatively used to produce silicomanganese and manganese ferroalloys.

Timminco, the only Canadian-owned bulk ferroalloy producer, shut down its complete silicon and manganese ferroalloy facilities in May 1987. One of the reasons associated with the closure was the availability of low-priced imports. In August 1987, the company restarted its largest silicon ferroalloy furnace, but did not restart its manganese furnaces. The silicon ferroalloy furnace represented about 40% of Timminco's total ferroalloy capacity and its production was primarily for use as a reductant in the magnesium operations at the company's Haley plant located in Ontario.

In May 1988, Timminco refired its second largest furnace. This furnace was brought into production to take advantage of increased prices. The restarting of this furnace resulted in the return to full capacity of Canada's silicon ferroalloy industry.

As a result of improved computerized production and quality programs initiated in 1987 and 1988, SKW Canada Inc. was able to improve its competitive position. These improvements and cost-cutting programs assisted the company in taking advantage of strong domestic and foreign markets.

The Mining Association of Canada completed a study in 1988 which concluded that the Canadian metal mining industry had, by 1987, doubled its productivity since 1981. The magnitude of this productivity increase combined with the continuation of competitive energy rates and the current studies by industry and governments to upgrade silica sand could provide incentive to establish additional silicon ferroalloy and/or silicon metal capacity in Quebec or Manitoba.

The Manitoba government, in cooperation with the federal government, has conducted studies for upgrading silica sand from the Black Island deposit in Manitoba to silicon metal as part of the Canada-Manitoba Mineral Development Agreement. Subsequent to these studies, Dow Corning Corporation, in association with the Manitoba Energy Authority (MEA), began research and development, utilizing plasma technology, to produce silicon metal.

Phase I of the joint venture was launched in November 1988, and involves an evaluation of silica sand from Selkirk Silica, a division of Marine Transport Limited, which currently operates a 150 000 t/y silica sand mine on Black Island in Lake Winnipeg. Subject to the results of the first phase, the second phase of the project is scheduled to start in October 1992. This phase will involve the design and construction of a pilot plant for the efficient production of silicon metal. The Black Island silica sand has inherent chemical and physical characteristics which could result in the economical upgrading of the material to silicon metal.

Domestic demand for silicon ferroalloys increased from 1986 through to the middle of 1989, mainly due to increased activity in the iron and steel industry. Demand decreased in the second half of 1989 due to reduced consumption of these alloys in the production of iron and steel.

Consumption of silicon ferroalloys in 1989 was estimated to be 83 500 t, 4.2% higher than in the previous year. Primary steel accounted for 81%, and iron and steel castings took 19%. Domestic consumption was equivalent to 65% of domestic production of silicon ferroalloys. The remainder of the production was exported.

Production of silicon ferroalloys in 1989 declined about 2.1% to 88 370 t. This is attributed to a decline in prices in the latter half of 1989 as well as a substantial increase in imports, estimated at 23%, over imports in 1988.

Silicon metal is used as an alloy in the production of nonferrous products and iron and steel. Silicon metal is also used in the chemical industry for producing silanes and silicones for use in electronic and solar systems.

Silicon metal consumption is estimated to have increased by about 5.5% in 1989, due mainly to increased demand for nonferrous alloys used in the manufacture of aluminum, brass, bronze and magnesium castings and, to a lesser extent, in the production of chemicals.

WORLD DEVELOPMENTS

Western world consumption of silicon ferroalloys, estimated at 2.01 Mt in 1988, represented an increase of 11% over 1987 consumption. High consumption during the latter half of 1986 through to the middle of 1989 and the withdrawal from stocks in 1986 and 1987 resulted in tight markets for silicon ferroalloys, which in turn led to price increases throughout this period.

The market eased in 1989 and western world consumption, estimated at 1.96 Mt, decreased 2.6% with respect to the previous year. North America accounted for about 33% of world consumption, Western Europe 27% and Asia 25%.

Western world production of silicon ferroalloy peaked at 2.19 Mt in 1988, an increase of 19% over 1985. A slight production deficit relative to demand, equivalent to 25 000 t/y on average, was experienced from 1986 to 1987 followed by production surpluses in 1988 and 1989.

Western world production of silicon ferroalloys was estimated at 2.01 Mt in 1989, about 4% less than in 1988. The reduction in production of silicon ferroalloys was due to reduced consumption of these alloys by the steel industry. Nevertheless, the western world effective production capacity of silicon ferroalloys in 1989 exceeded capacity in 1988 by 15%.

On a regional basis, North America accounted for an estimated production of 538 000 t of contained silicon in silicon ferroalloys in 1989, and Western Europe 594 000 t, with the European Economic Community accounting for about one third of Western Europe's production. Production in Asia was estimated at 375 000 t, an increase of 27% over 1985. The People's Republic of China accounts for about one half of Asia's production.

The largest producer of silicon ferroalloys in 1989 was Norway, accounting for about 15% of world production.

During the last four years, silicon ferroalloy production capacity has changed in response to changing market forces. Western world producers of silicon ferroalloys were unable to take advantage of the increase in demand in 1986, as they were busy reconditioning furnaces which had been mothballed due to declining prices in the first half of the 1980s. During the period 1987 through to 1989, effective capacity increased in North America as a result of restarting existing furnaces. In addition to this, new capacity was brought into production in Latin America and Asia in 1988. The increase in Asia occurred mainly in the People's Republic of China. Western Europe experienced a decline in effective capacity in 1987 followed by increased capacity in 1988 due to strong markets and rising prices. Western Europe capacity, however, during this period remained below what it had been in 1985 and 1986 due to plant obsolescence and uncompetitive energy rates.

PRICES

Ferrosilicon (50% Si and 75% Si) prices in 1987 ranged from US$0.68/kg to US$1.10/kg. Silicon metal prices in 1988 averaged US$1.50/kg. In December 1989, prices for 50% ferrosilicon became very erratic and peaked at US$1.27/kg. On average, however, ferrosilicon (50% Si and 75% Si) prices which were US$1.21/kg in 1988, decreased to US$0.93/kg in 1989.

The price reductions are attributed to reduced consumption and accumulated production surpluses at the end of 1989 (estimated at 328 000 t, equivalent to 17% of 1989 consumption). Silicon metal prices increased 4% in 1989 to US$1.56/kg.

OUTLOOK

The western world supply deficit for silicon ferroalloys in 1986 and 1987 which led to the withdrawal from stocks, is forecast to recur in 1991. The projected recurrence is attributed mainly to the continued down-sizing of Western Europe's silicon ferroalloy industry, a western world over-production in 1988 and 1989, and increased demand in Asia and Latin America.

The increase in demand in Asia and Latin America is associated with a forecasted increase in consumption needed to expand their construction and manufacturing industries. The down-sizing of Western Europe's silicon ferroalloy industry is expected to continue due to rising energy costs. The over-production in 1988 and 1989 which resulted in falling prices in the latter half of 1989 is forecast to result in the mothballing of capacity in 1990.

Subsequent to legislation by Brazil's congress, which called for the sale of ownership of foreign companies' mining interests within four years, 30 professional associations have drawn up a mining manifesto which calls for a new Brazilian mineral policy. These associations represent a broad cross-section of Brazil's economy from mining through to manufacturing. The manifesto calls for a re-examination of existing policies to establish new incentives which would promote financial investment for mining and mineral exploration, changes to existing legislation and the promotion of foreign investment in the minerals and metals sector of the economy.

Brazil's legislation and professional association manifesto could encourage further domestic and foreign investment which could accelerate expansion of its automotive and manufacturing industries. This could lead to increased domestic demand which would further contribute to world shortages of silicon ferroalloys.

A shift in the production of silicon ferroalloys, such as that experienced with chromium ferroalloys, from regions of high consumption (such as Japan, Western Europe and North America) to regions of low consumption (such as Brazil, India and the People's Republic of China) has occurred in the last two years.

A shift in the production of silicon ferroalloys to regions of competitive energy rates, such as Canada, is forecast to continue and to occur in this decade.

The down-sizing of Japan's silicon ferroalloy industry, which started in 1986, is expected to continue in the next decade due to high energy rates and plant obsolescence. This down-sizing has led Japan to become more import dependent, particularly on the People's Republic of China, and this is a trend which will likely continue.

The strong demand for silicon metal is expected to continue into the medium term due to a forecast increase in the production of nonferrous products and high-purity silicon. The nonferrous products are required to meet forecast production increases in the aerospace, automotive and the major appliance industries. The demand for high-purity silicon is in response to increased consumption in the high-technology industry.

Taking into consideration Canada's current and forecast competitive energy rates, the recent Canada-U.S. Free Trade Agreement and the high consumption of silicon ferroalloys and silicon metal in North America, it seems logical to expect future expansion in North America's silicon ferroalloy industry to take place in Canada.

Note: Information contained in this review was current as of mid-January 1990.

PRICES

Silicon prices published by Metals Week[1]		1987			1988			1989		
		January	July	December	January	July	December	January	July	December
					(US¢/kg)					
50% ferrosilicon imported		76.07 - 79.38	80.48 - 84.89	103.64 - 110.25	103.64 - 110.25	114.66 - 121.28	121.28 - 123.48	122.38 - 124.03	108.05 - 111.35	84.89 - 127.89
75% ferrosilicon imported		68.36 - 71.66	79.93 - 82.69	94.82 - 105.84	103.64 - 106.94	127.89 - 134.51	145.53 - 152.15	151.04 98.67	- 101.43	74.97 - 81.59
Silicon metal, of contained silicon, f.o.b. shipping point, lump, bulk and carload lots										
(% max. Fe)	(% max. Ca)									
0.35	0.07	148.51 - 151.81	148.51 - 151.71	148.51 - 150.71	148.51 - 151.81	157.66	157.66	157.66	157.66	157.66
0.50	0.07	143.46 - 146.74	143.46 - 146.74	143.46 - 146.74	143.46 - 146.74	156.56	156.56	156.56	156.56	156.56
1.00	0.07	136.71 - 140.57	138.10 - 136.71	136.71 - 140.51	154.35	155.46	154.35	154.35	154.35	154.35
Silicomanganese, U.S. import, 2% carbon, lump bulk lots, f.o.b. shipping point		37.49 - 40.79	40.79 - 43.00	49.61 - 52.92	48.51 - 52.92	56.28 - 57.88	68.36 - 70.56	79.38 - 81.59	90.41 - 92.61	59.92 - 59.54

Sources: Metals Week, Energy Mines and Resources Canada.
f.o.b. Free on board.
[1] All units of measure converted to metric.

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
	Ferrosilicon						
7202.21	-- Containing by weight more than 55% of silicon						
7202.21.10	--- Containing by weight less than 60% of silicon	Free	Free	Free	Free	6.2%	3.7%
7202.21.20	--- Containing by weight 60% or more of silicon but less than 90%	1.54¢ kg on the silicon content	Free	Free	Free	6.2%	3.7%
7202.21.30	--- Containing by weight 90% or more of silicon	4.41¢ kg on the silicon content	Free	Free	Free	6.2%	3.7%
7202.29.00	Silicon ferroalloys, n.e.s.	Free	Free	Free	Free	6.2%	3.7%
7202.29.00.10	-----Containing by weight more than 45% but not more than 55% of silicon	Free	Free	Free	Free	6.2%	3.7%
7202.29.00.20	-----Containing by weight not more than 45% of silicon	Free	Free	Free	Free	6.2%	3.7%
7202.30.00	- Ferro-silicomanganese	1.54¢ kg or fraction thereof on the manganese content	Free	Free	Free	5.5%	3.7%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition, Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Customs Tariff Schedules of Japan, 1989.

[1] GATT rate is shown, lower tariff rates may apply circumstantially.

n.e.s. Not elsewhere specified.

TABLE 1. CANADA, SILICON TRADE, 1988 and 1989

Item No.		1988		Jan.-Sept. 1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
	Silicon ferroalloys				
7202.21	--Containing by weight more than 55% of silicon				
	United States	9 717	9 705	9 657	11 806
	Japan	8 138	9 402	4 548	5 737
	West Germany	315	379	3 274	4 056
	Australia	-	-	300	411
	Other countries	2 083	2 627	235	275
	Total	20 253	22 113	18 014	22 285
7202.29.00	--Silicon ferroalloys, n.e.s.				
	United States	7 652	4 041	6 244	3 967
	Japan	2 243	2 557	1 199	814
	Other countries	101	44	229	132
	Total	9 996	6 642	7 672	4 913
Imports					
	Silicon ferroalloys				
7202.21	--Containing by weight more than 55% of silicon				
7202.21.10	---Containing by weight less than 60% of silicon				
	United States	2 118	1 982	741	1 021
	Brazil	-	-	25	50
	West Germany	90	184	-	-
	U.S.S.R.	38	40	-	-
	Total	2 247	2 207	766	1 072
7202.21 20	---Containing by weight 60% or more of silicon but less than 90%				
	United States	1 800	2 968	1 460	2 475
	West Germany	26	33	10	18
	France	17	58	3	2
	Belgium	2	3	-	-
	Total	1 845	3 064	1 473	2 497
7202.21.30	---Containing by weight 90% or more of silicon				
	Brazil	200	307	240	335
	United States	13	45	18	34
	Total	213	352	258	369
7202.29.00	--Silicon ferroalloys, n.e.s.				
7202.29.00.10	-----Containing by weight more than 45% but not more than 55% of silicon				
	United States	10 369	9 747	9 577	9 191
	U.S.S.R.	288	207	3 003	1 950
	West Germany	16	70	3	5
	Finland	4 098	2 211	-	-
	Japan	13	15	-	-
	Total	14 784	12 252	12 583	11 147
7202.29.00.20	-----Containing by weight not more than 45% of silicon				
	United States	944	1 322	610	816
	Brazil	73	153	19	27
	West Germany	-	-	3	6
	Other countries	49	95	-	-
	Total	1 066	1 570	632	850
7202.30	-Silicomanganese ferroalloys				
	South Africa	6 346	4 401	5 166	4 534
	United States	5 476	4 936	2 479	2 236
	Brazil	5 009	3 290	2 012	2 088
	Mexico	60	42	41	54
	Norway	250	154	3	4
	Total	17 141	12 825	9 701	8 918

Source: Statistics Canada.
^{p} Preliminary; n.e.s. Not elsewhere specified; - Nil.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, CONSUMPTION, EXPORTS, IMPORTS AND PRODUCTION OF SILICON FERROALLOYS, 1980-89

	Consumption[1]	Exports		Imports		Production[2]
	(tonnes)	(tonnes)	($000)	(tonnes)	($000)	(tonnes)
1980	63 321	52 164	33 886	18 508	13 869	96 977
1981	62 090	52 410	36 722	18 630	15 605	95 870
1982	46 122	40 826[r]	29 209	9 860	11 029	77 088[r]
1983	50 022	45 716	32 381	13 090	12 794	82 648[r]
1984	58 070	35 153	26 251	24 763[r]	19 496	68 460[r]
1985	55 957	33 224	22 816	12 048[r]	13 505	77 133[r]
1986	51 276	45 605	31 386	13 552[r]	13 798	83 329
1987	79 283[r]	28 275	19 595	12 367[r]	12 728	95 191
1988[p]	80 172	30 249	28 755	20 155	19 445	90 266
1989[e]	83 500	30 970	30 600	26 100	24 270	88 370

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Consumption as reported by consumers. [2] Consumption plus net exports equals derived production.

[p] Preliminary; [r] Revised; [e] Estimated.

TABLE 3. WESTERN WORLD, CONSUMPTION OF SILICON FERROALLOYS, 1985–89, 1990 AND 1993

Region	1985	1986	1987	1988	1989	1990[f]	1993[f]
				(000 t Si content)			
North America	558	553	587	683	636	670	685
Latin America	96	90	116	98	116	220	220
Western Europe	519	468	473	593	520	580	550
Asia (including People's Republic of China)	461	428	443	445	490	620	690
Other	197	182	168	190	195	205	220
Total	1 831	1 721	1 787	2 009	1 957	2 295	2 365

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries; Resource Strategies Inc., Ferrosilicon Industry Analysis July, 1988; Roskill Economics of Silicon Metal and Ferrosilicon, 1986.

[f] Forecast.

TABLE 4. WESTERN WORLD, PRODUCTION OF SILICON FERROALLOYS, 1985–89, 1990 AND 1993

Region	1985	1986	1987	1988	1989	1990[f]	1993[f]
				(000 t Si content)			
North America	458	397	425	591	538	500	600
Latin America	175	186	209	221	231	285	395
Western Europe	699	690	661	693	594	520	500
Asia (including People's Republic of China)	210	210	223	366	375	450	590
Other	237	223	260	380	365	325	305
Total	1 779	1 706	1 778	2 191	2 103	2 080	2 390

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries; Resource Strategies Inc., Ferrosilicon Industry Analysis July, 1988; Roskill Economics of Silicon Metal and Ferrosilicon, 1986.

[f] Forecast.

TABLE 5. WESTERN WORLD, EFFECTIVE[1] PRODUCTION CAPACITY OF SILICON FERROALLOYS, 1985–89, 1990 AND 1993

Region	1985	1986	1987	1988	1989	1990[f]	1993[f]
				(000 t Si content)			
North America	519	450	500	500	492	490	525
Latin America	282	260	204	244	378	350	350
Western Europe	769	769	550	620	637	564	500
Asia (including People's Republic of China)	273	279	274	375	492	576	596
Other	324	324	360	360	360	300	335
Total	2 167	2 082	1 863	2 099	2 359	2 280	2 306

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries; Resource Strategies Inc., Ferrosilicon Industry Analysis July, 1988; Roskill Economics of Silicon Metal and Ferrosilicon, 1986.

[1] Effective capacity is defined as capacity currently in production and unutilized capacity which is capable of being brought into production within a period of one year.

[f] Forecast.

TABLE 6. WESTERN WORLD, SILICON METAL CONSUMPTION, PRODUCTION AND CAPACITY, 1985 AND 1989

Region	Consumption		Production		Capacity	
	1985	1989	1985	1989	1985	1989
			(000 t)			
North America	155	189	135	180	184	216
Latin America	-	-	34	85	39	120
Western Europe	167	207	106	97	267	241
Asia (including People's Republic of China)	103	135	36	35	41	43
Other	64	80	191	196	200	220
Total	489	611	502	593	531	620

Sources: Energy, Mines and Resources Canada; U.S. Bureau of Mines, Mineral Commodity Summaries; Roskill Economics of Silicon Metal and Ferrosilicon, 1986; Resource Strategies Inc., Silicon Metal Industry Analysis, December, 1988.

Silver

1989

For further information on silver, contact the Director, Nonferrous Division, Mineral Policy Sector, EMR Canada. Telephone (613) 992-4001.

The silver market performed relatively poorly in 1989, due to a combination of soft investment demand and increased by-product production. It is estimated that over 60% of world silver output is produced as a by-product or co-product of gold and base metals. During 1989, the London silver price dropped to an average of US$5.50/oz. from $6.51 in 1988 and $7.02 in 1987.

CANADIAN DEVELOPMENTS

Canadian silver production declined in 1989 to 1262 t from 1443 t in 1988, mainly due to the closure of primary silver operations at Elsa, Yukon and Cobalt, Ontario. The value of production fell to $263 million from $386 million in 1988. With the closure of the two primary producers, domestic silver production in 1990 will be derived totally as a by-product of base-metal or gold-mining operations.

Although Agnico-Eagle Mines Limited closed its three primary silver mines at Cobalt, Ontario at the end of 1988, the company operated its mill and refinery through 1989 with both stockpiled and custom ore. Exploration continued during the year on the Penna deposit with additional work planned for 1990.

During 1989, British Columbia was the only province to register an increase in silver production. In addition to an increase of by-product output from a number of new gold mining operations in the province, the new $30.3 million Samatosum open-pit silver-base metals mine of Minnova Inc. and Rea Gold Corporation began commercial production in July. Reserves at the property, which is located 100 km north of Kamloops, have been calculated at 766 700 t grading 833 g/t silver, 1.6 g/t gold, 1.1% copper, 1.4% lead and 3.5% zinc. It is expected that the operation will produce close to 200 t of silver in 1990.

In the Yukon, United Keno Hill Mines Limited suspended mining and milling operations at Elsa in January 1989. While the closure was precipitated by the decline of silver prices, the company had been experiencing other problems including a shortage of skilled miners that prevented it from achieving production targets. The facilities have been placed on a care and maintenance basis pending a major increase in the price of silver.

WORLD DEVELOPMENTS

Estimated world silver mine production was 14 800 t in 1989 compared to 14 253 t in 1988. The largest producing nations are Mexico, the United States, Peru, the U.S.S.R., Canada, Australia and Poland.

The production of silver in the United States during 1989 was estimated at almost 1875 t, an increase from the 1661 t recorded in 1988. During 1989, the new Greens Creek mine in Alaska was brought on-stream. At full capacity, the mine will produce almost 200 t/y of silver making it the largest producer in the United States. In addition to silver, this operation will also produce some 36 000 oz. of gold, 25 000 t of zinc and 9000 t of lead in concentrate form each year. With ore reserves of about 3.2 Mt, mining operations are expected to last 10 years. Greens Creek is owned by RTZ Corporation PLC (53%), Hecla Mining Company (28%), CSX Corporation (12.6%) and Exalas Resources Inc. (6.3%).

In the 1990s, significant new by-product production in the United States will allow that country to become the largest silver producer in the world. Specific projects include the gold-silver developments of FMC Corporation at Paradise Creek and Echo Bay Mines Ltd.'s Cove mine, both in Nevada, as well as the Red Dog base-metals mine of Cominco Ltd. in Alaska.

Mexico and Peru, two of the world's major silver producers, experienced significant declines in output levels during 1988. While Peruvian production in 1989 increased to an estimated 1840 t from 1552 t in 1988, Mexican production was expected to decline further to about 2000 t from the 2412 t recorded in 1988. The declines experienced by both countries have largely been the result of continuing labour problems in their respective mining sectors.

With additional production from a number of new or expanded gold-silver mines, Chilean output is expected to increase significantly over the next several years. One of the largest projects is the La Coipa mine where silver output is expected to reach 497 t/y by 1991. The mine is owned by Consolidated TVX Mining Corporation and Placer Dome Inc. In 1988, Chile produced 486 t of silver.

CONSUMPTION AND USES

The major industrial uses for silver are in photographic materials, electrical and electronic products, sterling and electroplated ware, jewellery and brazing alloys and solders.

Despite the fact that developments in photographic technology and an increase in recycling have drastically reduced silver requirements for this application, photography has continued to be the most important industrial market for the metal. Overall consumption in 1988 was estimated at about 4700 t. One of the largest single photographic applications, accounting for about 40% of total consumption, is in the production of X-ray films. In view of increasing worldwide concern for human health, the use of X-ray film is expected to grow at an average annual rate of about 4% in the early 1990s.

The second largest market for silver, representing about 25% of industrial consumption in the United States, is in contact and conductor products for the electrical and electronics industries. While these industries have grown in importance, silver consumption in this area has remained relatively constant due to improvements in utilization technologies and miniaturization.

It was reported at the end of 1989 that the U.S. Navy was testing a new silver-iron battery for undersea vehicles. The new battery, patented by Westinghouse Electric Corporation, offers a significantly longer shelf life, quicker rechargeability and the capability to withstand more abuse than competing products.

Another promising new use is in a silver alloy coating for the bottom of microwaveable cookware which allows for the browning or crisping of food surfaces.

The use of silver in the production of coinage has been one of the fastest growing markets for the metal in recent years. In 1988, this included 800 t used in the minting of 329 coinages in 81 different nations, 550 t for numismatic coins and 245 t in silver bullion coins. With regard to the latter, two of the largest selling coins are the one ounce American Silver Eagle and the Canadian "Maple Leaf." The Royal Canadian Mint reported that sales of its "Maple Leaf" coin in 1989 totalled 3.25 million ounces. American Eagle sales in 1989 were reported to be over 5.8 million ounces.

With little prospect of significantly higher prices in the near term, investment demand for silver bullion during 1989 remained depressed. In 1988, private stocks of investment bullion declined by 650 t.

MARKETS, PRICES AND STOCKS

While silver is traded in the major financial centres around the world, the London Silver Market, part of the London Bullion Market Association, is the most important of the physical markets. In June 1989, the London Metal Exchange discontinued its silver contract due to low trading volumes. The most important futures market is the Commodities Exchange, Inc. (COMEX) in New York.

From a high of US$6.21/oz. in January 1989, London silver prices weakened thereafter with the metal testing the $5.00 barrier in September and again in October. The silver market recovered somewhat at the end of the year with prices during December averaging $5.57/oz. The average price in January 1990 was US$5.25/oz.

According to Handy & Harman, world stocks of silver bullion at the end of 1988 were estimated at almost 45 000 t. This included over 26 000 t of private investment stocks and almost 10 000 t held by governments, principally the United States, Mexico, India and Peru. At the end of 1989, COMEX stocks were reported at over 7400 t compared to 5440 t at the beginning of January.

The possibility of significant cuts to the large silver stocks held by governments has continued to exert a negative influence on the silver market. While the reduction of the large U.S. stockpile through coin and bullion sales has been fairly limited to date, large disposals by the United States or other governments, such as Peru, remain a concern.

OUTLOOK

Silver is in the unenviable position of being both an industrial and an investment metal. While industrial consumption is adversely affected by large price increases, investment demand benefits from the expectation of price escalation.

As an investment metal, silver is not universally perceived to have the attractiveness of gold in terms of being a store of value. Moreover, silver continues to suffer from its recent poor performance in comparison to alternative investment instruments, particularly gold. Unlike gold, for which the supply of new metal is largely dependent on its market price, the fact that a growing share of silver output is obtained as a by-product of base-metal mining decreases the sensitivity of silver supply to market factors. Since new mine production of silver, particularly from base-metal developments, will be more than sufficient to satisfy industrial demand in the foreseeable future, no dramatic increase in prices is anticipated in the short term. It is expected that silver prices will remain in the range of US$5.00 to $6.00/oz.

Note: *Information contained in this review was current as of mid-January 1990.*

TABLE 1. CANADA, SILVER PRODUCTION AND TRADE, 1988 AND

Item No.	1988	1989p
	(kilograms)	(kilograms)
Production (shipments)¹		
Newfoundland	x	x
Prince Edward Island	-	-
Nova Scotia	x	x
New Brunswick	202 635	196 516
Quebec	139 665	131 028
Ontario	434 325	356 421
Manitoba	32 257	32 265
Saskatchewan	x	x
Alberta	-	-
British Columbia	446 864	460 388
Yukon	159 135	64 172
Northwest Territories	25 867	20 376
Total	1 443 166	1 262 163
Total Value ($000)	386 271	263 308

				(Jan.-Sept.)	
		(kilograms)	($000)	(kilograms)	($000)
Exports					
2603.00	Copper ores and concentrates				
2603.00.81	------Silver content	275 293	62 541	330 120	58 426
2607.00	Lead ores and concentrates				
2607.00.81	------Silver content	113 031	18 706	61 286	8 865
2608.00	Zinc ores and concentrates				
2608.00.81	------Silver content	43 989	7 231	35 084	4 409
26.16	Precious metal ores and concentrates				
2616.10	-Silver ores and concentrates				
	West Germany	993	3 457	38 366	3 730
	Belgium	1 467	3 963	481	876
	Japan	98	28	446	90
	Finland	2	33	-	-
	United States	3 686	2 798	-	-
	Total	6 247	10 281	39 293	4 696
2616.10.81	------Silver content (included above)	14 704	2 208	3 671	1 577
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form				
7106.10	-Powder	2 721	70	306	25
	-Other				
7106.91	--Unwrought	1 126 803	303 089	692 929	150 710

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989[p]	
		(kilograms)	($000)	(kilograms)	($000)
7106.92	--Semi-manufactured	9 283	2 386	78 439	17 118
7107.00	Base metals clad with silver, not further worked than semi-manufactured	5 315	664	1 038	239
Imports					
2603.00.00	Copper ores and concentrates				
2603.00.00.81	------Silver content	9 307	2 347	3 628	710
2604.00.00	Nickel ores and concentrates				
2604.00.00.81	------Silver content	2	-	-	-
2607.00.00	Lead ores and concentrates				
2607.00.00.81	------Silver content	188 213	37 062	149 300	29 202
2608.00	Zinc ores and concentrates				
2608.00.00.81	------Silver content	9 421	2 001	7 412	1 122
26.16	Precious metal ores and concentrates				
2616.10	-Silver ores and concentrates				
	United States	40 338	291	-	-
	Bolivia	24 618	625	-	-
	Mexico	341	313	-	
	Other countries	-	-	9 407	111
	Total	65 298	1 231	9 407	111
2616.10.00.81	------Silver content (included above)	1 734	471	399	95
71.06	Silver (including silver plated with gold or platinum), unwrought or in semi-manufactured forms, or in powder form				
7106.10	-Powder	4 881	1 621	3 936	997
	-Other				
7106.91	--Unwrought	53 507	16 694	15 574	3 845
7106.92	--Semi-manufactured	56 712	13 657	138 744	13 998
7107.00	Base metals clad with silver, not further worked than semi-manufactured	905	513	25 467	943

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Includes recoverable silver in ores, concentrates and matte shipped for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; and base and other bullion produced from domestic ores.

[p] Preliminary; - Nil. x Confidential.

TABLE 2. CANADA, SILVER PRODUCTION, TRADE[1] AND CONSUMPTION, 1975, 1980, 1983–89

	Production[2]	In Ores and Concentrates	Exports, Refined Silver	Total	Imports, Refined Silver	Consumption,[3] Refined Silver
			(kilograms)			
1975	1 234 642	471 410	713 566	1 184 976	420 078	642 089
1980	1 070 000	396 690	881 761	1 278 451	339 180	265 938
1983	1 197 031	439 406	1 045 867	1 485 273	339 439	283 349
1984	1 326 720	423 963	1 081 391	1 505 354	215 192	299 440
1985	1 197 072	338 834	1 325 694	1 664 528	575 815	217 613
1986	1 087 969	373 232	1 292 552	1 665 784	169 074	312 905
1987	1 374 946	488 235	555 665	1 043 900	140 960	331 245
1988	1 443 166	438 559	1 144 122	1 582 680	116 005	457 698[p]
1989[p]	1 262 163	465 782[4]	772 712[4]	1 238 494[4]	183 720[4]	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning 1988, Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS classes 2603.00.81, 2607.00.81, 2608.00.81 and 2616.10. Refined silver includes HS classes 7106.10, 7106.91, 7106.92 and 7107.00. [2] Includes recoverable silver in: ores, concentrates and matte shipped for export; crude gold bullion produced; blister and anode copper produced at Canadian smelters; and base and other bullion produced from domestic ores. [3] Some years include only partial consumption for coinage. [4] Exports and imports are January–September figures.

[p] Preliminary; . . Not available.

TABLE 3. WORLD SILVER MINE PRODUCTION 1986–88

	1986	1987	1988
		(tonnes)	
Americas			
Mexico	2 418.4	2 414.9	2 412.0
United States	1 073.8	1 237.6	1 661.1
Peru	1 925.8	2 054.5	1 551.6
Canada	1 088.0	1 374.9	1 443.2
Chile	500.1	499.8	486.2
Bolivia	95.1	141.8	228.7
Other	253.1	185.8	245.1
Total America	7 354.3	7 909.3	8 027.9
Europe			
Spain	177.2	217.6	177.6
Sweden	235.0	215.0	193.2
Yugoslavia	177.4	151.1	139.0
Other	187.7	177.7	248.4
Total Europe	777.3	761.4	758.2
Africa			
South Africa	223.1	208.1	179.1
Morocco	165.2	157.9	165.6
Namibia	123.8	113.6	118.0
Other	100.8	112.9	93.1
Total Africa	612.9	592.5	555.8
Asia			
Japan	351.7	281.0	251.5
Other	257.9	302.0	335.0
Total Asia	609.6	583.0	586.5
Oceania			
Australia	1 022.8	1 119.3	1 113.6
Other	56.9	63.0	58.5
Total Oceania	1 079.7	1 182.3	1 172.1
Eastern countries			
U.S.S.R.	1 600.0	1 550.0	1 580.0
Poland	829.0	831.0	1 063.0
North Korea	295.0	300.0	310.0
People's Republic of China	105.0	125.0	150.0
Other	123.0	121.0	121.0
Total Eastern	2 952.0	2 927.0	3 224.0
Total	13 385.8	13 955.5	14 324.5

Sources: World Bureau of Metal Statistics; Energy, Mines and Resources Canada.

TABLE 4. AVERAGE ANNUAL SILVER PRICES, 1970–89

Year	Canada	United States	United Kingdom
	(C$/oz.)	(US$/oz.)	(Pence/oz.)
1970	1.851	1.771	73.778
1971	1.571	1.546	63.086
1972	1.671	1.685	67.403
1973	2.567	2.558	103.783
1974	4.595	4.708	199.819
1975	4.503	4.419	200.118
1976	4.291	4.353	242.423
1977	4.922	4.623	265.512
1978	6.171	5.401	282.203
1979	12.974	11.094	519.607
1980	24.099	20.632	900.778
1981	12.617	10.518	515.303
1982	9.831	7.947	455.331
1983	14.154	11.441	753.644
1984	10.521	8.141	607.056
1985	8.364	6.142	477.560
1986	7.532	5.470	373.030
1987	8.877	7.001	428.243
1988	8.325	6.535	367.783
1989	6.666	5.500	335.910

Sources: Northern Miner; Handy & Harman; London Silver Market.

TABLE 5. CANADIAN CONSUMPTION[1] OF UNMANUFACTURED SILVER, 1987 AND 1988

	1987	1988
	(kilograms)	
Chemicals -Silver Salts and Others	139 634	140 461
Coinage	127 740	109 239
Silver Alloys	16 754	21 910
Wire, Rod and Sheet	11 222	15 674
Sterling and Electroplating	11 198	13 855
Other Uses	24 697	156 559
Total	331 245	457 698

Source: Energy, Mines and Resources Canada.

[1] Available data as reported by consumers.

TABLE 6. MONTHLY AVERAGE SILVER PRICES, 1988 AND 1989

	London Silver Market		Handy & Harman	
	(C$/oz.)	(US$/oz.)	(C$/oz.)	(US$/oz.)
1988				
January	8.62	6.71	8.65	6.73
February	8.01	6.31	8.02	6.32
March	7.98	6.39	8.01	6.41
April	7.94	6.43	8.00	6.48
May	8.07	6.52	8.10	6.54
June	8.52	6.99	8.56	7.04
July	8.54	7.08	8.63	7.15
August	8.19	6.70	8.22	6.72
September	7.81	6.36	7.84	6.38
October	7.56	6.27	7.57	6.28
November	7.65	6.28	7.66	6.28
December	7.30	6.11	7.31	6.11
1989				
January	7.14	6.00	7.12	5.97
February	6.99	5.88	7.00	5.89
March	7.11	5.95	7.08	5.93
April	6.89	5.79	6.88	5.79
May	6.49	5.44	6.49	5.45
June	6.33	5.28	6.33	5.28
July	6.22	5.23	6.23	5.24
August	6.09	5.19	6.08	5.18
September	6.07	5.13	6.07	5.13
October	6.04	5.14	6.03	5.13
November	6.41	5.48	6.41	5.48
December	6.47	5.57	6.42	5.53

Sources: London Silver Market; Handy & Harman.

TABLE 7. SILVER CONSUMPTION IN MAJOR NON-SOCIALIST COUNTRIES, 1986–88

	1986	1987	1988
		(tonnes)	
Industrial Uses			
United States	3 785.3	3 688.9	3 732.4
Canada	298.6	323.5	339.0
Mexico	152.4	121.3	242.6
United Kingdom	637.6	668.7	693.6
France	510.1	609.6	699.8
West Germany	1 147.7	1 259.7	1 468.1
Italy	451.0	758.9	559.9
Japan	2 783.8	2 867.7	3 057.5
India	699.8	575.4	699.8
Others	1 810.2	1 866.2	1 928.4
Sub-Total	12 276.5	12 739.9	13 421.1
Coinage			
United States	230.2	469.7	236.4
Canada	62.2	99.5	31.1
Austria	31.1	62.2	202.2
Mexico	52.9	15.6	62.2
Others	432.3	317.3	404.3
Sub-Total	808.7	964.2	936.2
Total	13 085.2	13 704.2	14 357.3

Sources: Handy & Harman, "The Silver Market 1988".

Sodium Sulphate

1989

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Sodium sulphate is mainly produced from natural brines and deposits in alkaline lakes in areas with dry climates and restricted drainage, from subsurface deposits and brines, or as a by-product of chemical processes. Canada's sodium sulphate industry is based on extraction from natural brines and deposits in several alkaline lakes in Saskatchewan and Alberta. Seven plants producing natural sodium sulphate operated in Canada in 1989. By-product sodium sulphate is recovered at one rayon plant.

World production in 1989 was estimated by the U.S. Bureau of Mines at approximately 5.1 Mt, split about 48% from natural sources and 52% from various manufacturing processes, mainly as a by-product of viscose rayon production, hydrochloric acid, sodium dichromate and about six other chemical processes.

In the United States, natural and by-product sodium sulphate production is almost evenly split, with three natural producers having a total of 500 000 t/y capacity and about 10 synthetic producers with a total capacity of 485 000 t/y. In 10 European countries, sodium sulphate is produced almost entirely as a by-product of chemical processes, with a total capacity of 1.8 Mt/y. In addition, Spain has 0.5 Mt/y of natural sodium sulphate capacity.

PRODUCTION AND DEVELOPMENTS IN CANADA

Demand for Canadian natural sodium sulphate increased as a result of better domestic demand and a small rise in exports to the United States. The Saskatchewan and Alberta producers continued to keep the production level much below optimum capacity utilization to conform with sluggish market conditions that have now been in place for over four years.

Mine production in 1989 was estimated at 372 500 t compared to 323 360 t in 1988 and corresponding mine shipments were 369 500 t and 330 971 t respectively. The average unit value of shipments declined from $75.59/t in 1988 to $67.74/t in 1989. There was a shift in sales volume to the lower-priced salt cake which would accentuate the decline in unit value. Exports to the United States increased by 9.4% for the first 10 months of 1989 compared to the same period last year.

Besides natural sodium sulphate, about 20 000 t/y is produced as a by-product of chemical processes in central Canada. Between 35% and 45% of the total amount of sodium sulphate produced in Canada is the higher-grade and higher-priced "detergent-grade."

Potash Corporation of Saskatchewan (PCS) closed its sodium sulphate plant located at the Cory potash mine site in July 1988. The plant operated for about two and a half years, and never reached its designed output of 30 000 t/y. The plant is currently mothballed.

In July 1987, PCS completed the construction of a 10 t/d plant for the production of industrial-grade potassium sulphate at Big Quill Lakes. The plant uses the ion exchange process to produce a very pure, fine grain industrial product to a specification of 99.7% K_2SO_4. The plant produces a good product but is still operating at below capacity and on an experimental basis.

Two deposits in Saskatchewan (Snakehole Lake and Alsask Lake) and the deposit in Alberta (Metiskow Lake) are now all operated under the name Francana Minerals Inc., a division of Agassiz Resources Ltd. In 1989, the three plants produced at about two thirds of their combined capacity. Both detergent-grade and kraft-grade salt cake was produced.

Ormiston Mining and Smelting Co. Ltd. produced salt cake-grade material from brines of Horseshoe Lake operating at less than half of its designed capacity. Millar Western Industries Ltd. produced salt cake from the Whiteshore Lake at similar levels as last year or at about two thirds of nominal capacity.

Saskatchewan Minerals, a wholly-owned division of Dickenson Mines Limited, produced detergent-and kraft-grade material from the Ingebrit Lake and Chaplin Lake (kraft grade) without problems at about 60% of capacity.

There is only one remaining producer of synthetic sodium sulphate in Canada, which is located in Cornwall, Ontario. There, Courtaulds (Canada) Inc. produces a detergent-grade as a by-product of viscose rayon production at a rate of slightly in excess of 20 000 t/y. The capacity of this plant was raised to 27 000 t/y in 1989.

Deposits

The sodium sulphate deposits in Saskatchewan and Alberta have formed in shallow, undrained lakes and ponds where inflow is greater than outflow. Percolating ground waters carry dissolved salts into the basins from the surrounding soils. High rates of summer evaporation concentrate the brine to near saturation, and cooler fall temperatures cause crystallization and precipitation of sodium sulphate as mirabilite ($Na_2SO_4 . 10H_2O$). The cycle has been repeated year after year and thick deposits of hydrous sodium sulphate, accompanied by other salts and mud, have accumulated. Deposits in Saskatchewan are deemed to contain close to 100 Mt of anhydrous sodium sulphate.

Recovery and processing

Because most of the sodium sulphate is recovered by evaporation of concentrated brines or by dredging of the permanent beds of crystals, weather is as important for recovery of sodium sulphate as it is for its deposition. A large supply of fresh water is also essential. One method of sodium sulphate recovery is to pump lake brines that have been concentrated by hot summer weather into evaporating ponds or reservoirs. Continued evaporation produces a saturated or near-saturated solution of mirabilite. Differential crystallization occurs in the fall when the solution cools. Hydrous sodium sulphate crystallizes and precipitates, whereas sodium chloride, magnesium sulphate and other constituents remain in solution. Before freezing weather sets in, the impure solution remaining in the reservoir is drained or pumped back into the source lake. After the crystal bed has become frozen, harvesting is carried out using conventional earth-moving equipment. The harvested crystal is stockpiled adjacent to the plant.

Some operators use floating dredges to mine the permanent crystal bed. The slurry of crystal and brine is transported to a screening house at the plant by pipeline. If sufficiently concentrated, the brine from the screens is collected in an evaporation pond.

Since 1984, one company uses solution mining in lake beds that are 3-11 m thick. It pumps a concentrated brine to an air-cooled crystallizer at the plant where sodium sulphate is separated from other more soluble salts.

Processing of the natural salt consists of dehydration (Glauber's salt contains 55.9% water of crystallization) and drying. Commercial processes used in Saskatchewan include Holland evaporators, gas-fired rotary kilns, submerged combustion and multiple-effect evaporators. Subsequent crushing and screening results in a product with uniform grain size and good flow characteristics. Salt cake, the product used principally in the pulp and paper industry, contains a minimum of 97% Na_2SO_4. Detergent-grade material analyzes up to 99.7% Na_2SO_4. Uniform grain size and free-flow characteristics are important in material handling and use.

Of the seven plants in the Prairies, four are capable of producing detergent-grade sodium sulphate. Three plants have the capacity to produce 80% or more of their output as a high-grade product.

PRICES

Canadian list prices for natural sodium sulphate f.o.b. western plants were approximately $72 and $91/t respectively (quoted $80 and $100/s. t.) for salt cake and detergent-grade in 1989. Small quantities were sold near the list price while large lots were sold at substantial discounts. One-year contracts at firm prices are common. Realized prices are expected to remain at the same level during 1990. Prices for detergent-grade by-product sodium sulphate were in the order of $180-185/t delivered in Ontario in bulk shipment. For bagged product, the quote on December 31, 1989 was $219/t f.o.b. plant, e.g. Cornwall.

USES

The main end-uses for sodium sulphate are in the pulp and paper, detergent, glass and dyeing industries.

In the chemical pulping of wood, the digestion reagents consist of about two-thirds caustic soda and one-third sodium sulphide obtained by using sodium sulphate as make-up. About 33% of sulphur input is retained in the organic chemicals recycled in the process. Lately, technical improvements in the process significantly reduced the consumption of sodium sulphate per tonne of pulp produced to slightly less than 20 kg/t. The reduction in purchases is also due to the increasing use of chlorine dioxide as a bleaching agent. This bleaching chemical is manufactured internally and a sodium sulphate slurry is its by-product in many mills. Caustic soda and emulsified sulphur can be substituted for salt cake. Partial substitution reduces sulphur emissions, thus facilitating compliance with stricter environmental controls. The U.S. pulp and paper market accounts for about 35% of sodium sulphate usage.

Sodium sulphate is used as a builder, or more correctly as a diluent, in detergents (supplies the "bulk"). It is claimed to improve detergency through its effect on the colloidal properties of the cleaning system but is essentially inert. The curtailment in the usage of sodium tripolyphosphate (STPP) on grounds of pollution control also contributed to a decline in sodium sulphate production. The average sodium sulphate content of powder detergents is now between 20% and 25% in North America and Japan, about 25% in Western Europe and 50% in Eastern Europe. In the United States detergents represent 45% of the market for sodium sulphate but rapid growth in liquid detergents has had a negative impact on demand. Liquid detergents now represent 35-40% of the market but appear to have reached a plateau on the substitution path.

Some sodium sulphate is used by the glass industry as a source of Na_2O to speed up melting and prevent scum from forming on the surface of the melt. For typical container glass, sodium sulphate used is 0.36% of the weight of the glass produced; while flat glass requires 5-10 parts of sodium sulphate per 1000 parts of silica sand. However, particularly in the manufacture of flat glass and specialty glasses, calcium sulphate and soda ash can partially replace sodium sulphate. Both natural and synthetic salt cake can be used providing that the Fe_2O_3 content is less than 0.15%. Sodium sulphate in glass accounts for 5% of U.S. consumption.

Sodium sulphate is also used in the textile industry in the dyeing process, particularly in the dyeing of wool.

Sodium sulphate is used in the manufacture of a number of chemicals such as potassium sulphate, sodium sulphide, sodium silicate, sodium hyposulphite and sodium aluminum sulphate. Sodium sulphide is quantitatively the most important and is used for de-hairing hides in the tanning process.

Other end-uses include the manufacture of viscose sponges, feed supplements, boiler feed water treatments, veterinary medicines, sulphonated oils, printing inks, the ceramic industry and the photographic industry.

OUTLOOK

On balance, the North American natural sodium sulphate industry is expected to experience a flat growth in consumption over the next few years; some analysts expect a slight negative growth.

Canadian shipments in 1989 were slightly ahead of 1988 principally on account of higher exports to the United States, where a major producer of synthetic sodium sulphate ceased production during the year. In the North American pulp and paper industry, consumption of sodium sulphate was maintained at steady levels for the last two years, since substitution by caustic soda and emulsified sulphur ran its course. In the future, however, new processes will be introduced using much less sodium sulphate so that the average consumption per tonne is likely to decline substantially and will only be partially offset by a higher output of pulp and paper.

In the detergent industry, a worldwide growth rate of 1-2% is still possible on account of good potential in Asia and more recently in Eastern Europe. Liquid detergents in the United States now accounting for between 35% and 40% of the market do not pose a substantial further substitution risk, but the average sodium sulphate content in powders will continue to decline slowly. The introduction of "compact powders" which only carry 1-6% sodium sulphate has not met with anticipated results in North America, but compact powders are currently being introduced in Europe.

The United States, which accounts for about 20% of world consumption of sodium sulphate and had an import reliance factor of 16%, will probably increase its domestic output in 1990 and 1991; therefore, Canadian exports are expected to stagnate at current levels or even decline slightly. Imports from Mexico, although not large, may gain some ground at the expense of Canadian sales.

Note: Information contained in this review was current as of mid-January 1990.

TABLE 1. CANADA, NATURAL SODIUM SULPHATE PRODUCTION AND TRADE 1988 AND 1989

		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production					
Shipments					
Saskatchewan		x	22 331	x	22 781
Alberta		x	2 685	x	2 250
Total		330 971	25 016	369 500	25 031
Imports				(Jan.-Sept.)	
2833.11	Disodium sulphate				
	United Kingdom	5 722	319	3 769	173
	United States	834	98	1 074	115
	West Germany	11	1	33	4
	Total	6 567	419	4 876	293
Exports					
2833.11	Disodium Sulphate				
	United States	137 515	13 527	108 090	9 355
	Venezuela	13 052	1 656	8 165	450
	Other countries	2	120	1	19
	Total	150 569	15 303	116 256	9 824

Sources: Energy, Mines and Resources Canada; Statistics Canada.
p Preliminary; x Confidential.
Note: Numbers may not add to totals due to rounding.

TABLE 2. CANADA, NATURAL SODIUM SULPHATE PLANTS, 1989

	Plant Location	Source Lake	Annual Capacity (tonnes)
Alberta			
Agassiz Resources Ltd.[1]	Metiskow	Metiskow	55 000
Saskatchewan			
Agassiz Resources Ltd.[1]	Cabri	Snakehole and Verlo	60 000
Agassiz Resources Ltd.[1]	Hardene	Alsask	45 000
Millar Western Industries Ltd.	Palo	Whiteshore	109 000
Ormiston Mining and Smelting Co. Ltd.	Ormiston	Horseshoe	90 700
Saskatchewan Minerals[2]	Chaplin	Chaplin	90 000
Saskatchewan Minerals[2]	Fox Valley	Ingebrigt	163 000
Total			612 700

Source: Company reports.
[1] Francana Minerals Inc. [2] A division of Dickenson Mines Limited.

TABLE 3. CANADA, SODIUM SULPHATE PRODUCTION, TRADE AND CONSUMPTION 1970, 1975, AND 1980-89

	Production[1]	Imports[2]	Exports	Consumption[3]
		(tonnes)		
1970	445 017	26 449	108 761	291 439
1975	472 196	22 638	178 182	256 385
1980	496 000	20 211	245 831	232 045
1981	535 000	12 481r	284 284	216 298
1982	547 000	17 293	367 931	191 988
1983	453 939	22 479	265 753	190 625
1984	389 086	20 562	233 776r	235 504
1985	366 217	33 409	210 851	241 143
1986	370 726	17 551	233 397	228 360
1987	342 076	17 194	168 097	188 626
1988	330 971	6 567[4]	150 569[4]	187 838
1989p	369 500	. .	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Producers' shipments of crude sodium sulphate. [2] Includes Glauber's salt and crude salt cake. [3] Available data as reported by consumers. [4] Disodium sulphate only.

p Preliminary; r Revised; . . Not available.

TABLE 4. CANADA, AVAILABLE DATA ON SODIUM SULPHATE CONSUMPTION[1], 1986-88

	1986	1987	1988p
		(tonnes)	
Pulp and paper	164 061	142 370	144 845
Cleansers	54 808	38 707	34 278
Primary glass and containers	7 471	6 714	8 068
Other products[2]	2 020	835	647
Total	228 360	188 626	187 838

[1] Available data, as reported by consumers. [2] Nonferrous smelting and refining, feed industry and other minor uses.

p Preliminary.

Stone

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Production of all types of stone in 1989, including dimension stone, chemical and metallurgical grades, pulverized stone and crushed material, remained about the same in terms of quantity but increased in value to more than $600 million, according to preliminary figures.

Considerable additional data, particularly on regular aggregates including sand and gravel and lightweight aggregates, are included in the chapter on "Mineral Aggregates."

Strong demand continued for dimension stone, mainly for exterior and interior finish for office buildings in the United States and Canada. Fabrication of thin custom veneer and panels, along with the automated manufacture of granite tiles using the latest European technology, has contributed greatly to the value of output in this sector. More recently, demand for premium-quality, rough granite block, particularly from Quebec, has increased substantially. Quantitative data are lacking on rough stone and fabricated products. However, the value of production of shaped, construction-quality granite finished in Quebec, from both domestic and imported block, is estimated to have increased about tenfold during the period 1980-89 inclusive.

CANADIAN DEVELOPMENTS

Although rough dimension stone accounts for a relatively small proportion of stone production in terms of total volume, the most rapid expansion in terms of output and trade, particularly relating to construction-quality stone, has resulted in a broad international industry developing over an 8-10 year period. Production of granite in particular has grown considerably and the wide variety of attractive raw material is becoming more recognized. Most activity is situated in Quebec (80-90%) and Ontario, both recognized as sources of superior quality stone. However, limestone/marble, sandstone and slate are also important in certain regions (Figure 1). The value of production of rough granite, mainly from Quebec, indicates an eightfold increase from 15 000 t valued at $850 000 in 1977 to 69 000 t valued at $9.6 million in 1987 (Figure 2).

Rough granite used for building construction increased in relative importance from about 24% of total sales to 70% of sales during the period 1977-87. Correspondingly, granite used for monumental/ornamental purposes declined in relative importance but grew moderately in absolute terms. The use of limestone and marble in construction has also increased, particularly during the past two years. However, up-to-date data are not available.

Since 1982, the relatively strong U.S. dollar has maintained the competitiveness of many imported products including dimension stone finished at modern plants in Europe. Similarly, with established expertise and good access to domestic and imported raw material, Canadian producers installed new capacity using mainly Italian technology developed since 1980. In Quebec, Granicor inc. opened several quarries in the past few years to supply high-quality granite in a range of colours. Also, members of the Quebec Granite Producers Association, including Polycor Inc., Granit Bussière Inc., A. Lacroix Ltée and Dumas et Voyer Ltée, as well as other companies, expanded and reported substantial growth in production as well as exports. In Ontario, Nelson Granite Limited expanded to produce more rough granite for construction needs to complement the existing manufacture of monuments and curbing. B.C. Granite Manufacturing Limited, of Delta, British Columbia (formerly Canroc Manufacturing Limited Partnership), continued development work on several quarries to provide additional raw material for the company's modern stone processing plant serving markets in western North America and the Pacific Rim.

Several provinces are assessing their stone resources and, with the rejuvenated interest in much of the historical record, early works such as those by W.A. Parks[1] and by M.F. Goudge[2] have become classics and remain applicable in many regions of the country. Many programs were assisted initially through federal-provincial Mineral Development Agreements as part of Economic and Regional Development Agreements (ERDAs). Promotional literature and display samples make up part of these projects.

Atlantic Provinces

Limestone

Occurrences of limestone in the Atlantic provinces are common and have been systematically catalogued in the past.[3,4,5] Deposits of commercial importance are being worked in three of the four provinces.

In Newfoundland, outside of periodic operations to secure limestone aggregate for highways, the main exploitation has been by North Star Cement Limited at Corner Brook.[6] Recently, the Iron Ore Company of Canada (IOC) in western Labrador brought into production a dolomitic marble for use in self-fluxing "dolomitic-type" iron ore pellets.[7] In 1989, The Newfoundland Resources & Mining Company Limited, controlled by Explaura Holdings PLC of the United Kingdom, began commissioning its tidewater property on the Port-au-Port Peninsula to quarry and ship limestone aggregates. Plans call for shipping 1-2 Mt/y, increasing to 3-5 Mt within five years.

In Nova Scotia, limestone occurs in the central and eastern parts of the province and is quarried for numerous uses. In New Brunswick, quarries operate at three locations - Brookville, Elm Tree and Havelock - for use as crushed stone aggregate, for agricultural application, for lime manufacture and for use as a flux. Studies continued to assess opportunities associated with the dimension and crushed stone industries.

Granite

Occurrences of granite in the Atlantic region have been described by Carr.[8] In Nova Scotia, a blue-grey granite produced near Nictaux is used mainly in the monument industry. Activity relating to granite, as well as to other types of stone, was summarized in two recent publications.[9,10] Granitile Inc., of Concord, Ontario, proceeded with construction of a granite tile manufacturing plant in Port Hawksbury, Nova Scotia. Construction Aggregates Ltd., owned by Lone Star Industries, Inc. of Greenwich, Connecticut, continued shipping high-quality granite aggregate from the company's Strait of Canso quarry. Sea-going barges and ships loaded at the plant site deliver to aggregate-poor regions as distant as Houston, Texas. Kelly Rock Limited proceeded with plans to develop a quarry to produce crushed granite at Kelly's Mountain.

Granite is quarried intermittently from a number of deposits in New Brunswick.[11] A red, fine-to-medium-grained granite is produced near St. Stephen, and fine-grained, pink, grey and blue-grey granites are available in the Hampstead (Spoon Island) district. In the Bathurst area, a brown-to-grey, coarse-grained granite is quarried on demand, as is a salmon-coloured, medium-grained granite near Antinouri Lake and a black, ferromagnesian rock in the Bocabec River area. Red granite is available in the St. George district.

In Newfoundland, interest is centred on "black granite" (gabbro), a pink, coarse-grained megacrystic granite having feldspar crystals up to 7 cm long, and a red granite near the village of Seal Cove on the south-central coast. On the west coast of Labrador, the Nain anorthosite complex, which hosts occurrences of an attractive dark-coloured chatoyant labradorite, continues to attract interest.[7]

Sandstone and Slate

Island Tile & Slate Limited, after start-up in 1986, continued producing slate from a quarry at Nut Cove, near Bourgoyne's Cove, Trinity Bay, Newfoundland. Red-, green- and purple-coloured non-fading products are available for uses in roofing and flooring. In Nova Scotia, medium-grained buff sandstone is quarried at Wallace for use as heavy riprap and for dimension stone.

In New Brunswick, a red, fine-to-medium-grained sandstone has been quarried in Sackville for use in construction. Deposits are exploited intermittently throughout Kent and Westmorland counties for local projects and for highway work.

Quebec

Limestone

Limestone occurs in the St. Lawrence and Ottawa River valleys and in the Eastern Townships. Limestone blocks and other shapes are produced for construction uses in the Montreal region and at various locations throughout the province. Marble has been produced in the Eastern Townships and the Lac St-Jean areas.

Granite

Quebec accounts for up to 90% of Canada's shipments of granite for dimension stone. Since 1979, total shipments of rough and partially finished stone have doubled and, according to estimates, the value of construction-quality granite from domestic and imported block increased from about $11 million to more than $100 million in 1989. As a result of improved marketing and advanced processing technology, about 25 companies now quarry granite mainly in the Rivière-à-Pierre, the Lac St-Jean and the Appalachians regions.[12] These companies account for more than 40 quarries classified as producers of granite for construction, monuments and/or furniture.[13] Tulinor Inc. proceeded with construction of a tile manufacturing plant in Grandes-Bergeronnes.

Sandstone

Of five operations producing from sandstone resources in Quebec, only one, in Hemmingford, Huntingdon County, is listed as marketing flagstone and construction blocks.

Ontario

Limestone

Although limestones in Ontario range in age from Precambrian through Devonian, major production comes from Ordovician, Silurian and Devonian deposits. A major provincially funded, three-volume study entitled "Limestone Industries of Ontario," was completed in 1989 to assess the geological resources, economic factors and the related industries mainly associated with limestone, dolostone and marble.[14]

Arriscraft Corporation quarries a blue-grey-to-buff-coloured dolomitic limestone from the Amabel formation near Wiarton. Sold under the name of Adair marble, this attractive stone has been used increasingly for up-scale construction projects including the new Canadian Chancery in Washington, D.C.

Marble

This is widely distributed over southern Ontario in the Canadian Shield and is defined as a metamorphic rock consisting mainly of recrystallized calcite and/or dolomite. International Larder Minerals Inc. of Toronto continued negotiations with a view to establishing an agglomerated marble tile plant at Madoc. Stoklosar Marble Quarries Limited, a long-time producer of stone products in the region, is an integral part of the plan. With regard to marble dimensional stone, some relatively small-scale uses were reported in the past.[15] Most recently, Two Island Marble Corporation is evaluating a large occurrence in the Renfrew area.

Steep Rock Calcite, a wholly-owned subsidiary of Pleuss-Staufer AG of Switzerland operating at Tatlock and Perth, is the main producer of high-purity carbonate fillers in Ontario.

Granite

Granites occur in northern, northwestern and southeastern Ontario.[16,17,18,19,20,21,22] Six companies are active, with Nelson Granite Limited being the major producer of pink granite near Vermilion Bay, where there are exceptionally large reserves. In addition, reserves of grey-, white- and dark-coloured varieties are becoming more available. Canadian Shield Quarries Ltd., part of the Société d'Exploration Minière Vior Inc. - La Société d'Exploration Minière Mazarin Inc. Group, is active in the Sudbury area where deposits of gabbroic anorthosite "black granite" are attracting much attention. Granimar Quarries Ltd., with fabricating facilities in Montreal, reactivated a red granite quarry in the Kingston area. Detailed activity throughout the province is highlighted in an annual directory.[23]

Sandstone

Sandstone quarried near Toronto, Ottawa and Kingston has been used widely in Ontario as building stone.[24] Medina sandstone is fine-to-medium-grained and varies from grey, through buff and brown to red, with some mottled units. Potsdam stone is medium-grained and varies from grey-white through salmon-red to purple, and mottled. Current uses are as rough building stone, mill blocks from which sawn pieces are obtained, ashlar, flagstone and as a source of silica for ferrosilicon and glass.

Western Provinces

Limestone

From east to west through the southern half of Manitoba, rocks of Precambrian, Ordovician, Silurian, Devonian and Cretaceous ages occur. Limestones of commercial importance occur in the three middle periods and range from magnesian limestone through dolomite to high-calcium limestones.[2,25] A recent publication includes current developments relating to limestone as well as to other types of stone.[26]

Tyndall Stone, a mottled dolomitic limestone often referred to as "tapestry" stone, is the best known Manitoba limestone. It is quarried by Gillis Quarries, Limited at Garson, about 50 km northeast of Winnipeg, and more than 25 000 m² were used recently on the new Canadian Museum of

Civilization very attractively situated on the Ottawa River in Hull, Quebec. Limestone from Moosehorn, 160 km northwest of Winnipeg, and from Mafeking, 40 km east of the Saskatchewan border and 160 km south of The Pas, is transported to Manitoba and Saskatchewan centres for use in the metallurgical, chemical, agricultural and construction industries.

The eastern ranges of the Rocky Mountains contain Cambrian to Triassic limestones. Major deposits characterized by a wide variety of types occur in Devonian and Carboniferous rocks.[27] In southwestern Alberta, high-calcium limestone is mined at Exshaw, Kananaskis and Crowsnest, chiefly for the production of cement and lime, for metallurgical and chemical uses and for use as a crushed stone. Similar uses are made of limestone quarried at Cadomin, near Jasper.[6]

In British Columbia, large volumes of limestone are mined each year for cement and lime manufacture, for use by the pulp and paper industry and for various construction applications.[6] Quarries on Texada Island, British Columbia have for many years provided limestone to markets in Vancouver and in Washington State by virtue of their quality and position relative to tidewater shipping facilities. Deposits on Aristazabal Island have been developed for the export market. Other operations at Terrace, Clinton, Westwold, Popkum, Dahl Lake, Doeye River and Cobble Hill produced stone for construction and for filler use.[28]

Granite

In Manitoba, at Lac du Bonnet northeast of Winnipeg, two companies quarry pink-to-reddish granite which is mainly shipped to Quebec and the United States for finishing. A new fabricating plant in Winnipeg, Canital Granite Ltd., is now utilizing local block as well as stone from nearby Ontario to produce thin-cut tile for exterior cladding. Approximately 10 Manitoba granite occurrences were assessed recently under a federal-provincial Mineral Development Agreement to determine their physical and aesthetic qualities.[29]

In Saskatchewan and Alberta, granite is not quarried on a regular basis. Most of the recent work to evaluate potential reserves has been undertaken by the Saskatchewan Geological Survey.[30,31,32]

In British Columbia, a medium-grained, light-grey-to-blue-grey granodiorite has been produced from Nelson Island and other areas. Although small quantities of stone are supplied from local sources, the industry has not flourished since the 1930s. Currently, a major processing plant in Vancouver, formerly CANROC and now B.C. Granite Manufacturing Limited, is being reactivated to serve western North American and Pacific Rim markets using local as well as imported block. A recent publication by the Province of British Columbia highlights current and past quarrying and uses relating to granite, marble, flagstone, jade and rhodonite.[33]

Sandstone

Sandstone for building and ornamental uses quarried near Banff, Alberta, is hard, fine-grained, medium-grey and is referred to as "Rundal Stone."

CONSUMPTION AND MARKETS

Most dimension stone, including granite, limestone, marble, sandstone and slate, is used in construction-oriented projects. Chemical-related uses mainly apply to limestone, and large-scale consumption in the cement, lime, glass and metal-smelting industries.

Granite, as a dimension stone, is processed mainly for interior and exterior floor- and wall-cladding, modular block panelling and for monuments. Increasingly, a broader range of colour and texture or fabric is being sought by developers and architects. Detailed consumption data for rough and finished granite, as well as for other types of stone, are not available. However, trends can be established based on production, imports and less well-defined export data. During the period 1980-89, production of rough granite, as well as imports of roughly trimmed and cut granite block (codes 2516.11 and 2516.12), more than doubled, as indicated. Exports of rough granite have increased about eightfold since 1985 in response to demand in Japan, the United States and Italy. Exports of granite monumental or building stone (code 6802.23 - cut or sawn and code 6802.93 - worked) were mainly to the United States, and since 1983 this large market has been the main reason for increased fabricating capacity.

Some specific uses in the chemical field are: neutralization of acid waste liquors; extraction of aluminum oxide from bauxite; manufacture of soda ash, calcium carbide, calcium nitrate and carbon dioxide; in pharmaceuticals; as a disinfectant; in the manufacture of dyes, rayons, paper, sugar and glass; and in the treatment of water. Dolomitic limestone is used in the production of magnesium chloride and other magnesium compounds.

Agricultural limestone is used to control soil acidity and to add calcium and magnesium to the soil. Limestone and lime are used as soil stabilizers, particularly on highway construction projects.

Dolomite is the source of magnesium metal produced by Haley Industries Limited at Haley, Ontario; the company also uses a high-calcium lime from southeastern Ontario in the production of calcium metal. Dead-burned dolomitic limestone for use as a refractory is produced at Dundas, Ontario by Steetley Quarry Products Inc. A magnesite deposit at Eon Mountain in British Columbia has been quarried by Baymag Mines Co. Limited since 1982 to produce caustic magnesia, refractory grade MgO, and more recently, fused magnesia.

TARIFFS AND TRADE

The remaining tariffs between Canada and the United States on all square or rectangular block or slab, along with tariffs relating to articles of granite, simply cut or sawn, were phased out in 1989. Tariffs relating to other types of worked stone, simply cut or sawn, as well as to tiles and similar articles, will be phased out in 1993. Some natural stone products classified as millstones or grindstones are subject to a later phase-out expiring in 1998.

Cold Spring Granite Co., as a leading member of the U.S. Ad Hoc Granite Trade Group, withdrew its pending appeal in a case against granite from Spain and Italy. The company, with about 40 quarries and six plants (including a quarry in Manitoba), is a major world producer and apparently withdrew the appeal considering this to be appropriate in view of the expanding global nature of the stone industry.

OUTLOOK

The dimension stone industry, given new technology relating to quarrying, fabrication and installation, along with continuing favourable economic conditions, is expected to continue to grow. Although the most rapid expansion has been associated with new quarries and fabricating plants in Quebec, modernization by several producers across Canada has increased the availability of high-quality finished products at competitive prices. Markets for building stone face competition from substitutes such as aluminum, concrete, glass and ceramics. However, use of modern gang saws for cutting thin panels for cladding fitted to steel or concrete construction units is expected to continue improving cost effectiveness. For aesthetic reasons, demand for natural materials - and products at least partially based on these - is expected to expand as new markets are developed. Efforts continue on behalf of the industry to illustrate to developers and architects the availability in Canada of a wide range of architectural stone.

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Note: *Information contained in this review was current as of mid-January 1990.*

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2514.00	Slate, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape				
2514.00.10	--- Crude or roughly trimmed	Free	Free	Free	Free
2514.00.20	--- Merely cut, by sawing or otherwise, into blocks or slabs	5.5%	3.5%	Free	Free
2514.00.90	--- Other, including powder and waste	10.2%	6.5%	Free	Free
25.15	Marble, travertine, ecaussine and other calcareous monumental or building stone of an apparent specific gravity of 2.5 or more, and alabaster, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape.				
2515.11.00	-- Crude or roughly trimmed				
2515.11.10	---- Marble	Free	Free	Free	Free
2515.11.20	---- Travertine	Free	Free	Free	Free
2515.12.00	-- Merely cut, by sawing or otherwise into blocks or slabs				
2515.12.10	--- Marble	4%	Free	Free	Free
2515.12.20	--- Travertine	4%	Free	Free	Free
2515.20	- Ecaussine and other calcareous monumental or building stone; alabaster				
2515.20.10	--- Crude or roughly trimmed	Free	Free	Free	Free
2515.20.20	--- Merely cut, by sawing or otherwise into blocks or slabs	5.5%	3.5%	Free	Free

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada
25.16	Granite, porphyry, basalt, sandstone and other monumental or building stone, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape.				
	- Granite				
2516.11.00	-- Crude or roughly trimmed	Free	Free	Free	Free
2516.12.00	-- Merely cut, by sawing or otherwise into blocks or slabs	5.5%	Free	Free	Free
	- Sandstone				
2516.21.00	-- Crude or roughly trimmed	Free	Free	Free	Free
2516.22.00	-- Merely cut, by sawing or otherwise, into blocks or slabs	5.5%	3.5%	Free	Free
2516.90	- Other monumental or building stone				
2516.90.10	--- Crude or roughly trimmed	Free	Free	Free	Free
2516.90.20	--- Merely cut, by sawing or otherwise, into blocks or slabs	5.5%	3.5%	Free	Free
25.17	Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, for road metalling or for railway or other ballast, shingle and flint, whether or not heat-treated; macadam of slag, dross or similar industrial waste, whether or not incorporating the materials citedthe first part of the heading, tarred macadam granules, chippings and powder, of stones of heading No. 25.15 or 25.16, whether or not heat-treated				

2517.10.00	- Pebbles, gravel, broken or crushed stone, of a kind commonly used for concrete aggregates, etc.	Free	Free	Free	Free
2517.20.00	- Macadam of slag, dross or similar industrial waste	Free	Free	Free	Free
2517.30.00	- Tarred macadam	10.2%	6.5%	Free	Free
	- Granules, chippings and powder, of stones of heading No. 25.15 or 25.16, whether or not heat treated				
2517.41.00	-- Of marble	Free	Free	Free	Free
2517.49	-- Other				
2517.49.10	--- Limestone roofing granules	Free	Free	Free	Free
2517.49.90	--- Other	10.2%	6.5%	6.1%	Free
6801.00.00	Setts, curbstones and flagstones of natural stone (except slate)	5.5%	Free	3.3%	3.3%
6802.10	- Tiles, cubes and similar articles, whether or not rectangular (including square), not more than 7 cm; artificially coloured granules, chippings and powder				
6802.10.10	--- Roofing granules, artificially coloured	Free	Free	Free	5.5%
6802.10.90	--- Other	12.5%	8%	7.5%	5.5%

TARIFFS (cont'd)

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
	- Other monumental or building stone and articles thereof, simply cut or sawn, with a flat or even surface				
6802.21	-- Marble, travertine and alabaster	5.7%	3.5%	3.4%	
6802.21.10	--- Travertine	5.7%	3.5%	3.4%	4.8%
6802.21.50	--- Other	5.7%	3.5%	3.4%	1.6%
6802.22.00	-- Other calcareous stone	8%	5%	4.8%	4.8%
6802.23.00	-- Granite	5.5%	Free	Free	Free
6802.29.00	-- Other stone	8%	5%	4.8%	6%
	- Other				
6802.91	--- Marble, travertine and alabaster	9%	Free	5.4%	2.2%-4.8%
6802.92.00	--- Other calcareous stone	9.9%	6.5%	5.9%	4.8%
6802.93.00	-- Granite	10.2%	6.5%	Free	Free
6802.99.00	-- Other stone	10.2%	6.5%	6.1%	5.2%
6803.00	Worked slate and articles of slate or of agglomerated slate				
6803.00.10	--- Roofing slate	Free	Free	Free	5.2%
6803.00.90	--- Other	10.2%	6.5%	6.1%	2.9%
6804.10.00	- Millstones and grindstones for milling, grinding or pulping	10.2%	Free	8.1%	Free
6804.23.00	-- Of natural stone	10.2%	Free	8.1%	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, STONE EXPORTS AND IMPORTS, 1988 AND 1989

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Exports					
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	105	11	330	133
2515.11	Marble and travertine, crude or roughly trimmed	556	332	-	-
2515.12	Marble and travertine, merely cut, by sawing or otherwise into blocks, etc.	764	1 147	1	4
2516.11	Granite crude or roughly trimmed	14 393	2 308	21 741	4 337
2516.12	Granite, merely cut, by sawing or otherwise into blocks, etc.	65 905	12 520	56 676	8 375
2516.21	Sandstone, crude or roughly trimmed	8 300	37	-	-
2516.22	Sandstone, merely cut, by sawing or otherwise into blocks, etc.	1 935	64	20	3
2516.90	Monumental or building stone n.e.s.	6 378	554	246	208
2517.10	Pebbles, gravel broken or crushed stone used for aggregates, etc.	1 704 539	11 187	990 220	8 425
2517.41	Marble granules, chipping and powder of 25.15 or 25.16 heat-treated or not	1 908	502	-	-
2517.49	Granules, chippings and powder, n.e.s. of 25.15 or 25.16 heat-treated or not	149 405	1 015	49 993	703
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	..	57	-	-
6802.10	Tiles etc. rectangular or square not more than 7 cm., etc.; artificially coloured granules, chippings and powder	649	629	..	142
6802.21	Monumental or building stone, cut or even, marble, travertine and alabaster	..	560	..	11
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	..	18	-	-
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	..	11 396	..	5 934
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	..	199	..	249
6802.91	Worked monumental or building stone n.e.s., marble, travertine or alabaster	..	390	..	312
6802.92	Worked monumental or building stone n.e.s., calcareous stone n.e.s.	..	1	-	-
6802.93	Worked monumental or building stone n.e.s., granite	..	13 178	..	13 631
6802.99	Worked monumental or building stone, n.e.s.	..	435	..	69
6803.00	Worked slate and articles of slate or agglomerated slate	..	34	-	-
6804.10	Millstones and grindstones for milling, grinding or pulping	..	5 972	..	6 327
6804.23	Millstones, grindstones, etc. of natural stone	..	277	..	278
Imports					
2514.00	Slate, whether or not roughly trimmed or merely cut, etc.	3 155	636	1 865	612
2515.11	Marble and travertine, crude or roughly trimmed	5 045	1 791	1 640	512

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)					
2515.12	Marble and travertine, merely cut, by sawing or otherwise into blocks, etc.	4 925	3 103	2 072	1 209
2516.11	Granite, crude or roughly trimmed	42 197	8 909	37 922	7 773
2516.12	Granite, merely cut, by sawing or otherwise into blocks, etc.	4 900	2 357	1 266	748
2516.21	Sandstone, crude or roughly trimmed	896	104	1 488	172
2516.22	Sandstone, merely cut, by sawing or otherwise into blocks, etc.	15 929	2 363	10 139	2 052
2516.90	Monumental or building stone n.e.s.	11 360	1 564	5 972	1 188
2517.10	Pebbles, gravel broken or crushed stone used for aggregates, etc.	599 739	3 598	594 005	3 413
2517.41	Marble granules, chipping and powder of 25.15 or 25.16 heat-treated or not	33 871	3 369	25 121	3 121
2517.49	Granules, chippings and powder, n.e.s. of 25.15 or 25.16 heat-treated or not	133 403	2 041	107 085	1 284
6801.00	Setts, curbstones and flagstones of natural stone (except slate)	. .	1 153	. .	803
6802.10	Tiles etc., rectangular or square not more than 7 cm., etc.; artificially coloured granules, chippings and powder	33 701	4 154	24 352	3 458
6802.21	Monumental or building stone, cut or even, marble, travertine and alabaster	. .	2 411	. .	2 489
6802.22	Monumental or building stone, cut or sawn, flat or even, other calcareous stone	. .	298	. .	210
6802.23	Monumental or building stone, cut or sawn, flat or even, granite	. .	2 275	. .	927
6802.29	Monumental or building stone, cut or sawn, flat or even, n.e.s.	. .	827	. .	400
6802.91	Worked monumental or building stone n.e.s., marble, travertine or alabaster	. .	39 351	. .	41 753
6802.92	Worked monumental or building stone n.e.s., calcareous stone n.e.s.	. .	130	. .	267
6802.93	Worked monumental or building stone n.e.s., granite	. .	15 657	. .	17 602
6802.99	Worked monumental or building stone, n.e.s.	. .	729	. .	605
6803.00	Worked slate and articles of slate or agglomerated slate	. .	2 402	. .	2 487
6804.10	Millstones and grindstones for milling, grinding or pulping	. .	2 146	. .	1 636
6804.23	Millstones, grindstones, etc. of natural stone	. .	2 268	. .	2 183

Sources: Energy Mines and Resources Canada; Statistics Canada.
p Preliminary; . . Not available; n.e.s. Not elsewhere specified; - Nil.

TABLE 2. CANADA, TOTAL PRODUCTION OF STONE, 1987-89

	1987		1988		1989p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province[1]						
Newfoundland	1 041	9 303	1 023	7 248	590	4 707
Nova Scotia	5 015	24 963	6 567	34 453	6 416	33 747
New Brunswick	2 999	16 676	2 445	15 266	2 250	13 614
Quebec	44 440	217 766	46 450	234 775	42 206	220 639
Ontario	61 966	294 665	58 460	313 141	56 870	316 068
Manitoba	4 393	18 116	2 877	12 537	3 041	14 076
Saskatchewan	2	4	–	–	–	–
Alberta	1 940	7 720	528	3 350	282	2 762
British Columbia	6 496	34 234	3 571	21 264	4 830	26 364
Northwest Territories and Yukon	677	2 165	108	232	172	622
Total	128 969	625 613	122 030	642 267	116 657	632 599
By use[2]						
Dimensional stone						
Rough	187	15 047	..	..	..	..
Monumental and ornamental stone (n.f.)	62	7 043	..	..	..	..
Other (flagstone, curbstone, paving blocks, etc.)	30	2 776	..	..	..	..
Chemical and metallurgical						
Cement plants, Canada	12 543	26 300	..	..	..	..
Cement plants, foreign	726	1 911	..	..	..	..
Lining, open-hearth furnaces	–	–	..	..	..	..
Flux in iron and steel furnaces	1 192	4 663	..	..	..	..
Flux in nonferrous smelters	–	–	..	..	..	..
Glass factories	196	3 509	..	..	..	..
Lime plants, Canada	3 134	16 271	..	..	..	..
Lime plants, foreign	585	2 221	..	..	..	..
Pulp and paper mills	263	1 962	..	..	..	..
Sugar refineries	45	223	..	..	..	..
Other chemical uses	847	5 798	..	..	..	..

TABLE 2. (cont'd)

	1987		1988		1989p	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By use[2] (cont'd)						
Pulverized stone						
Whiting (substitute)	–	–	. .	. .	. .	. .
Asphalt filler	–	–	. .	. .	. .	. .
Dusting, coal mines	–	–	. .	. .	. .	. .
Agricultural purposes and fertilizer plants	1 393	16 437	. .	. .	. .	. .
Other uses	446	14 691	. .	. .	. .	. .
Crushed stone for						
Manufacture of artificial stone	–	–	. .	. .	. .	. .
Roofing granules	401	7 862	. .	. .	. .	. .
Poultry grit	–	–	. .	. .	. .	. .
Stucco dash	23	1 506	. .	. .	. .	. .
Terrazzo chips	–	–	. .	. .	. .	. .
Rock wool	–	–	. .	. .	. .	. .
Rubble and riprap	1 840	10 112	. .	. .	. .	. .
Concrete aggregate	11 589	59 728	. .	. .	. .	. .
Asphalt aggregate	9 459	47 297	. .	. .	. .	. .
Road metal	52 951	233 462	. .	. .	. .	. .
Railroad ballast	5 972	33 094	. .	. .	. .	. .
Other uses	25 086	113 698	. .	. .	. .	. .
Total	128 969	625 613	. .	. .	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Data exclude stone used in the Canadian cement and lime industries. [2] Data include stone used in the Canadian cement and lime industries.

p Preliminary; . . Not available; – Nil; n.f. Not finished or dressed.

Note: Totals may not add due to rounding.

TABLE 3. CANADA, PRODUCTION OF LIMESTONE, 1986-88

	1986[1]		1987[1]		1988[2]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	262	1 512	473	5 121	768	5 221
Prince Edward Island	–	–	–	–	–	–
Nova Scotia	619	3 543	788	4 011	156	1 891
New Brunswick	1 107	6 392	748	6 754	724	6 403
Quebec	30 721	126 559	35 271	153 170	35 440	157 562
Ontario	51 470	218 416	58 902	263 758	54 979	278 819
Manitoba	3 801	20 549	3 682	13 602	2 320	8 831
Saskatchewan	–	–	2	4	–	–
Alberta	1 354	6 031	1 649	6 994	261	2 565
British Columbia	2 950	14 519	3 407	15 711	1 910	11 692
Northwest Territories and Yukon	342	1 057	245	1 037	6	79
Total	92 625	398 578	105 167	470 162	96 564	473 063
By use[2]						
Dimensional stone						
Rough	49	1 636	54	1 895	..	..
Monumental and ornamental stone (n.f.)	–	–	...	40	..	..
Other (flagstone, curbstone, paving blocks, etc.)	15	1 097	20	1 790	..	..
Chemical and metallurgical						
Cement plants, Canada	11 306	22 675	12 274	25 566	..	..
Cement plants, foreign	468	1 316	724	1 864	..	..
Lining, open-hearth furnaces	–	–	–	–	..	..
Flux in iron and steel furnaces	1 065	4 401	1 192	4 663	..	..
Flux in nonferrous smelters	62	1 443	67	1 352	..	..
Glass factories	190	3 423	196	3 509	..	..
Lime plants, Canada	3 556	18 288	3 134	16 271	..	..
Lime plants, foreign	396	1 740	585	2 221	..	..
Pulp and paper mills	230	1 745	260	1 914	..	..
Sugar refineries	32	159	45	223	..	..
Other chemical uses	617	3 967	780	4 446	..	..

TABLE 3. (cont'd)

	1986[1]		1987[1]		1988[2]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By use[2] (cont'd)						
Pulverized stone						
Whiting (substitute)	32	1 938	34	2 021	. .	. .
Asphalt filler	52	495	40	306	. .	. .
Dusting, coal mines	6	188	6	178	. .	. .
Agricultural purposes and fertilizer plants	1 046	12 349	1 307	15 094	. .	. .
Other uses	25	424	57	957	. .	. .
Crushed stone for						
Manufacture of artificial stone	–	–	–	–	. .	. .
Roofing granules	99	1 170	95	1 580	. .	. .
Poultry grit	55	2 073	40	816	. .	. .
Stucco dash	–	–	19	1 234	. .	. .
Terrazzo chips	–	–	–	–	. .	. .
Rock wool	–	–	–	–	. .	. .
Rubble and riprap	521	2 060	386	2 116	. .	. .
Concrete aggregate	10 661	53 790	9 118	45 127	. .	. .
Asphalt aggregate	6 446	28 357	7 417	35 732	. .	. .
Road metal	36 413	153 380	47 735	210 970	. .	. .
Railroad ballast	915	3 451	983	4 270	. .	. .
Other uses	18 368	77 013	18 600	84 007	. .	. .
Total	92 625	398 578	105 167	470 162	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Data include stone used in the Canadian cement and lime industries. [2] Data exclude stone used in the Canadian cement and lime industries.

. . Not available; – Nil; n.f. Not finished or dressed; . . . Too small to be expressed.

Note: Totals may not add due to rounding.

TABLE 4. CANADA, PRODUCTION OF MARBLE, 1986-88

	1986		1987		1988	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	–	–	–	–	–	–
Nova Scotia	3	151	3	155	3	163
New Brunswick	–	–	–	–	–	–
Quebec	369	5 133	487	7 153	542	7 069
Ontario	189	8 928	222	10 580	218	11 335
Manitoba	–	–	–	–	–	–
Saskatchewan	–	–	–	–	–	–
Alberta	–	–	–	–	–	–
British Columbia	–	–	–	–	–	–
Northwest Territories and Yukon	–	–	–	–	–	–
Total	560	14 213	712	17 887	763	18 567
By use						
Dimensional stone						
Rough	20	882	25	. .	. .	. .
Monumental and ornamental stone (n.f.)	3	359	. . .	2	. .	. .
Chemical process stone						
Flux in nonferrous smelters	. . .	1	–	–	. .	. .
Pulp and paper mills	10	158	3	48	. .	. .
Other chemical uses	–	–	–	–	. .	. .
Pulverized stone						
Whiting	–	–	–	–	. .	. .
Agricultural purposes and fertilizer plants	76	1 182	86	1 343	. .	. .
Other uses	218	9 463	246	11 059	. .	. .
Crushed stone for						
Artificial stone	17	413	27	616	. .	. .
Roofing granules	2	52	5	113	. .	. .
Poultry grit	. . .	5	. . .	19	. .	. .
Stucco dash	2	119	3	151	. .	. .
Terrazzo chips	4	134	6	458	. .	. .
Concrete aggregate	44	369	67	636	. .	. .
Road metal	57	243	70	370	. .	. .
Other uses	107	832	171	1 704	. .	. .
Total	560	14 213	712	17 887	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; – Nil; n.f. Not finished or dressed; . . . Too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 5. CANADA, PRODUCTION OF GRANITE, 1986-88

	1986		1987		1988	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	94	666	480	3 539	151	1 309
Nova Scotia	2 705	14 742	2 826	14 609	5 364	27 450
New Brunswick	1 724	7 750	2 023	9 321	1 535	8 186
Quebec	4 565	33 500	6 047	42 733	7 077	53 076
Ontario	1 363	15 618	1 744	16 988	1 885	18 852
Manitoba	846	7 855	620	4 495	441	3 684
Saskatchewan	–	–	–	–	–	–
Alberta	–	–	–	–	–	–
British Columbia	2 874	13 431	3 082	18 377	1 655	9 426
Northwest Territories and Yukon	4	20	136	597	10	49
Total	14 176	93 583	16 957	110 660	18 120	122 031
By use						
Dimensional stone						
Rough	57	7 309	69	9 605	. .	. .
Monumental and ornamental stone (n.f.)	53	7 396	39	6 128	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	11	1 002	4	411	. .	. .
Chemical and metallurgical						
Lining, open-hearth furnaces	–	–	–	–	. .	. .
Pulverized stone						
Asphalt filler	56	162	62	170	. .	. .
Crushed stone for						
Artificial stone	–	–	4	50	. .	. .
Roofing granules	256	5 421	300	6 168	. .	. .
Poultry grit	2	169	2	157	. .	. .
Stucco dash	–	–	–	–	. .	. .
Rubble and riprap	1 051	7 363	1 094	6 877	. .	. .
Concrete aggregate	981	5 618	1 949	11 434	. .	. .
Asphalt aggregate	1 508	8 242	1 837	10 550	. .	. .
Road metal	3 449	16 670	3 623	15 902	. .	. .
Railroad ballast	2 333	15 574	2 923	19 431	. .	. .
Other uses	4 419	18 657	5 050	23 776	. .	. .
Total	14 176	93 583	16 957	110 660	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; – Nil; n.f. Not finished or dressed.
Note: Totals may not add due to rounding.

TABLE 6. CANADA, PRODUCTION OF SANDSTONE, 1986-88

	1986		1987		1988	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland	191	1 009	64	462	73	604
Nova Scotia	1 083	4 980	1 337	6 130	1 007	4 902
New Brunswick	117	58	141	81	92	57
Quebec	1 386	8 652	1 621	11 086	1 706	12 327
Ontario	58	598	189	1 595	176	1 559
Manitoba	–	–	–	–	–	–
Saskatchewan	–	–	–	–	–	–
Alberta	1	57	1	42	3	151
British Columbia	25	235	7	145	6	147
Northwest Territories and Yukon	–	–	–	–	–	–
Total	2 861	15 588	3 360	19 542	3 063	19 746
By use						
Dimensional stone						
Rough	28	1 612	38	2 123	. .	. .
Monumental and ornamental stone (n.f.)	18	651	23	873	. .	. .
Lining, open-hearth furnaces	–	–	1	65	. .	. .
Other (flagstone, curbstone, paving blocks, etc.)	2	103	5	511	. .	. .
Chemical process stone						
Cement plants, foreign	–	–	2	47	. .	. .
Crushed stone for						
Poultry grit	–	–	. . .	5	. .	. .
Stucco dash	–	–	1	122	. .	. .
Rock wool	–	–	. . .	5	. .	. .
Rubble and riprap	79	231	360	1 119	. .	. .
Concrete aggregate	281	1 622	439	2 477	. .	. .
Asphalt aggregate	215	921	204	1 015	. .	. .
Road metal	571	2 553	706	3 170	. .	. .
Railroad ballast	–	–	–	–	. .	. .
Other uses	1 668	7 894	1 581	8 011	. .	. .
Total	2 861	15 588	3 360	19 542	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.
. . Not available; – Nil; n.f. Not finished or dressed; . . . Too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 7. CANADA, PRODUCTION OF SHALE, 1986-88

	1986[2]		1987[3]		1988[3]	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
By province						
Newfoundland[1]	17	145	24	145	31	114
Nova Scotia	27	25	61	58	37	47
New Brunswick	9	62	87	520	94	621
Quebec	990	3 193	1 014	3 625	1 684	4 741
Ontario[1]	1 018	3 862	909	1 689	1 201	2 515
Manitoba	. . .	2	91	19	115	22
Saskatchewan	–	–	–	–	–	–
Alberta	271	668	290	684	265	634
British Columbia	–	–	–	–	–	–
Northwest Territories and Yukon	138	339	297	531	93	105
Total	2 471	8 296	2 772	7 270	3 520	8 799
By use						
Dimensional stone[1]	. . .	102	. . .	. . .	. .	. .
Chemical and metallurgical						
Cement plants, Canadian	229	641	269	734	. .	. .
Crushed stone for	–	–	–	–	. .	. .
Roofing granules	–	–	. . .	1	. .	. .
Rubble and riprap	. . .	. . .	. . .	. . .	. .	. .
Concrete aggregate	–	–	16	55	. .	. .
Road metal	553	1 962	818	3 049	. .	. .
Other uses	1 689	5 592	1 669	3 432	. .	. .
Total	2 471	8 296	2 772	7 270	. .	. .

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Includes slate. [2] Data include stone used in the Canadian cement and lime industries. [3] Data exclude stone used in the Canadian cement and lime industries.

. . Not available; – Nil; . . . Too small to be expressed.

Note: Totals may not add due to rounding.

TABLE 8. CANADA, PRODUCTION OF STONE BY TYPES[1], 1980, 1985, 1987 AND 1988

	1980		1985		1987		1988	
	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)	(000 t)	($000)
Granite	39 983	140 914	17 219	95 424	16 957	110 660	18 120	122 031
Limestone	58 191	185 085	77 874	317 862	105 167	470 162	96 564	473 063
Marble	316	1 807	571	13 966	712	17 887	763	18 567
Sandstone	3 064	11 540	3 011	15 310	3 360	19 542	3 063	19 746
Shale[2]	1 812	1 810	1 561	3 059	2 772	7 361	3 520	8 860
Total	103 366	341 156	100 236	445 622	128 969	625 613	122 030	642 267

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Data exclude stone used in the Canadian cement and lime industries. [2] Includes slate.
Note: Totals may not add due to rounding.

TABLE 9. CANADA: ROUGH GRANITE – SUMMARY OF PRODUCTION AND TRADE

	Production[1]	Imports[2]	Exports[2]
	(Quantities in tonnes) Value = $ x 10⁶		
1980	81 000 $5.6	24 130 $1.9	5 019[3] $0.7
1985	104 000 $12.8	34 468 $6.2	12 511[3] $1.7
1986	121 000 $15.7	33 994 $6.6	18 450[3] $2.7
1987	112 000	46 370 $7.9	37 450[3] $6.0
1988	140 000•	47 097 $11.3	80 300 $14.8
1989	160 000•	52 274 $11.7	106 395 $17.2

Sources: Energy, Mines and Resources Canada; Statistics Canada.
[1] Includes rough stone for construction, monumental/ornamental and other uses. [2] Includes codes 2516.11 (roughly trimmed block) and 2516.12 (cut block by sawing or otherwise). Some re-exports to the United States may also be involved. [3] Coded as building stone, rough (90% is considered to be granite).
• Estimate.

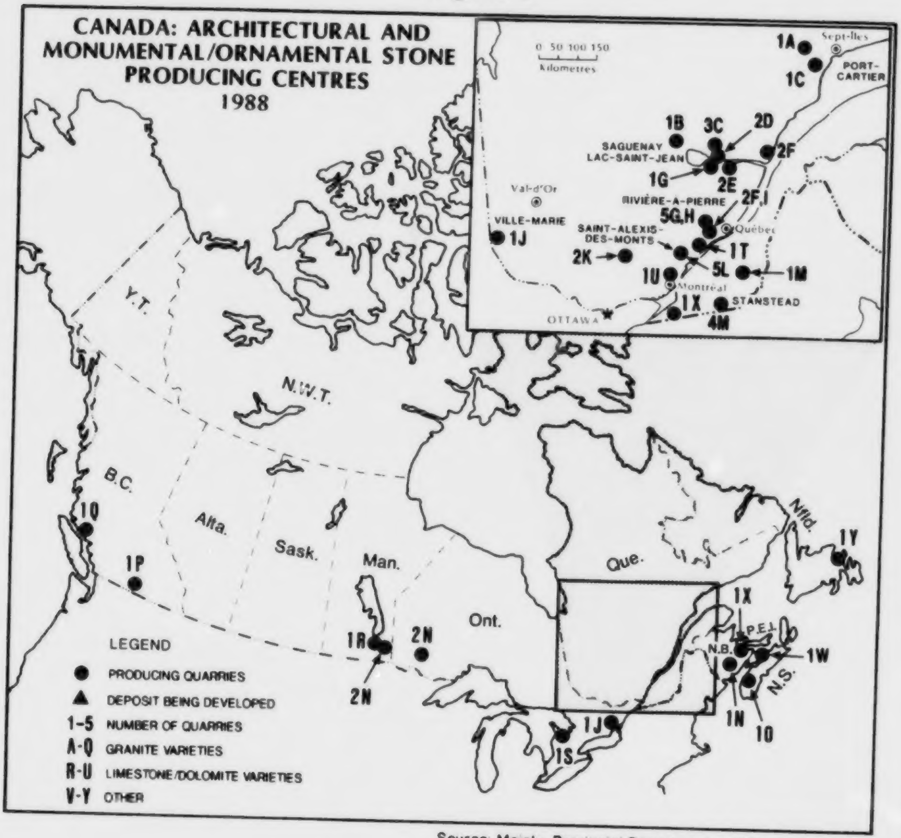
TABLE 10. CANADA, VALUE OF CONSTRUCTION BY PROVINCE[1], 1987–89

	1987			1988			1989		
	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total	Building Construction[2]	Engineering Construction[2]	Total
				($ millions)					
Newfoundland	892	648	1 540	899	691	1 590	929	694	1 622
Nova Scotia	1 578	650	2 228	1 643	712	2 354	1 679	738	2 417
New Brunswick	1 214	457	1 671	1 306	452	1 758	1 393	526	1 919
Prince Edward Island	206	76	282	241	91	333	237	99	336
Quebec	14 629	4 172	18 800	15 583	5 347	20 931	15 205	6 070	21 274
Ontario	24 754	6 343	31 097	27 112	7 291	34 403	28 806	8 186	36 991
Manitoba	2 034	926	2 960	2 038	1 022	3 060	2 122	1 204	3 326
Saskatchewan	1 880	1 506	3 386	1 949	1 808	3 757	2 086	1 724	3 810
Alberta	4 575	5 915	10 490	4 891	7 045	11 937	4 961	7 042	12 003
British Columbia, Yukon and Northwest Territories	6 146	3 371	9 517	7 065	3 528	10 593	7 662	3 836	11 498
Canada	57 908	24 064	81 971	62 727	27 989	90 715	65 078	30 119	95 197

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Actual expenditures 1987, preliminary actual 1988, intentions 1989. [2] Includes total value of new and repair work purchased.

Figure 1


CANADA: ARCHITECTURAL AND
MONUMENTAL/ORNAMENTAL STONE
PRODUCING CENTRES
1988
0 50 100 150
Kilometres
1A
Sept-Iles
1C
PORT-CARTIER
1B
3C
2D
SAGUENAY
LAC-SAINT-JEAN
2F
1G
2E
Val-d'Or
RIVIÈRE-A-PIERRE
2F,I
5G,H
VILLE-MARIE
1J
SAINT-ALEXIS-
DES-MONTS
Québec
2K
1T
5L
1M
1U
Montréal
1X
STANSTEAD
OTTAWA
4M
Y.T.
N.W.T.
B.C.
1O
Alta.
Sask.
Man.
1P
Nfld.
1Y
Que.
1X
P.E.I.
Ont.
1R
2N
2N
N.B.
1W
N.S.
1N
1O
1J
1S
LEGEND
● PRODUCING QUARRIES
▲ DEPOSIT BEING DEVELOPED
1-5 NUMBER OF QUARRIES
A-Q GRANITE VARIETIES
R-U LIMESTONE/DOLOMITE VARIETIES
V-Y OTHER

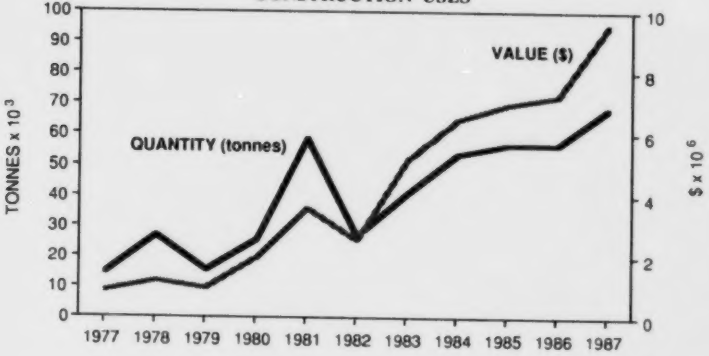
Source: Mainly Provincial Departments of Mines and Energy

A	FINE-GRAINED PINKISH-GREY BANDED GNEISS
B	MEDIUM-GRAINED MAHOGANY GRANITE
C	COARSE-GRAINED BLACK ANORTHOSITE
D	MEDIUM-GRAINED BLACK GABBROIC ANORTHOSITE
E	MEDIUM-GRAINED PINKISH-GREY QUARTZ MONZONITE
F	FINE-GRAINED PINK GRANITIC GNEISS
G	COARSE-GRAINED GREEN CHARNOCKITE
H	COARSE-GRAINED PINK-GREY OR BROWN-GREY GRANITE
I	MEDIUM GRAINED GREY DIORITIC GNEISS
J	MEDIUM-GRAINED RED GRANITE
K	FINE-GRAINED PINK APLITE
L	COARSE-GRAINED BROWN OR RED QUARTZ MONZONITE
M	MEDIUM-GRAINED GREY GRANITE
N	MEDIUM-GRAINED PINK GRANITE
O	FINE-GRAINED BLUE-GREY GRANITE
P	COARSE CORAL PINK GRANITE
Q	MEDIUM-GRAINED BLUE-GREY GRANITE
R	LIGHT-COLOURED MOTTLED DOLOMITIC LIMESTONE (TYNDALL)
S	FINE-MEDIUM CRYSTALLINE BLUE-GREY TO BUFF MARBLE/DOLOSTONE (ARRISCRAFT)
T	MEDIUM-GRAINED LIGHT BROWNISH-GREY LIMESTONE (DESCHAMBAULT)
U	MEDIUM-GRAINED BLUE-GREY LIMESTONE (CHAZY)
V	MEDIUM-GRAINED OLIVE SANDSTONE
W	FINE-MEDIUM-GRAINED OLIVE-BROWN AND BLUE-GREY SANDSTONE
X	FINE-MEDIUM GRAINED WHITE TO BUFF SANDSTONE (POTSDAM)
Y	VERY FINE-GRAINED VARICOLOURED SLATE

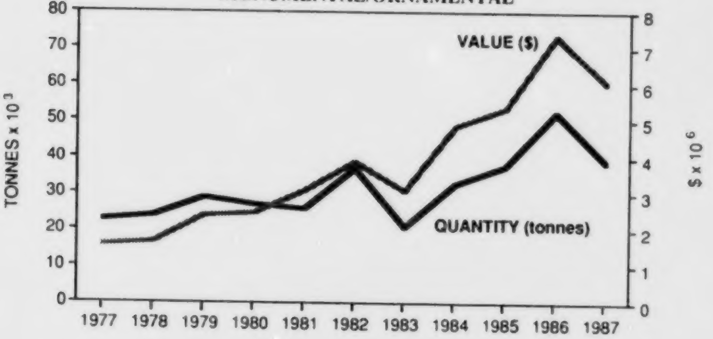
Figure 2

CANADA - PRODUCTION OF ROUGH GRANITE
(SOLD AND USED BY PRODUCERS)

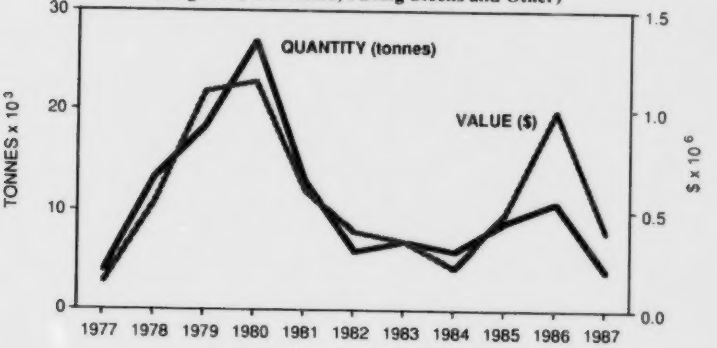
CONSTRUCTION USES



MONUMENTAL/ORNAMENTAL



OTHERS
(Flagstone, Curbstone, Paving Blocks and Other)



Sulphur

1989

M. Prud'homme

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SUMMARY

In 1989, the world sulphur market was depressed due to a much-reduced primary consumption by major buyers. The weak demand was triggered by a trade dispute between Morocco and India early in February which lasted ten months. Canadian suppliers incurred a shortfall of close to 1.5 Mt in export volumes compared to 1988 due to lower sales to Morocco. During 1989, sulphur production in the U.S.S.R. fell short of its expectations due to technical problems. Output decreased slightly in France, West Germany and Canada, while it remained fairly constant in Mexico, Saudi Arabia and Poland. Meanwhile, production rose in the Middle East, particularly in Iraq and Iran.

Canadian elemental sulphur production decreased 4% while shipments declined dramatically by 20% to an estimated 6.52 Mt. This decline was mainly due to a 30% drop in sulphur exports. In 1989, Canadian production accounted for 13.6% of world elemental sulphur production while Canadian exports accounted for 40% of world trade.

In 1989, price increases signalled late in 1988 were not realized except for a slim 10% increase in contract prices throughout the first half. Overall, contract prices for offshore exports of elemental sulphur from Vancouver declined 20% from US$98-105/t early in January to US$77-86/t at year-end.

DEVELOPMENTS IN CANADA

Elemental Sulphur

In 1989, production of elemental sulphur in Canada decreased 4% to 5.83 Mt. Production from natural gas processing accounted for 88.7%, while the remainder was from oil sands plants (8.6%) and oil refineries (2.7%). Sulphur output in British Columbia showed a significant 35% increase over 1988. This gain was offset by reduced production from oil sands and natural gas plants in Alberta. Extremely cold temperatures that prevailed in Alberta during February caused technical shutdowns at Husky Oil Ltd.'s Ram River plant for several weeks until normal operating rates resumed in March.

Shipments of elemental sulphur were estimated at 6.52 Mt, a 20% decrease from 1988. Sulphur deliveries in Canada increased slightly and accounted for 12% of total shipments while exports to the United States accounted for 18%. Offshore exports declined 30% over 1988.

On a nine-month basis for 1989, Canada's exports of sulphur declined 27% to 4.0 Mt compared to 5.5 Mt in the same period last year. Canada sold sulphur to 31 countries. In 1989, the United States emerged as the dominant exports destination for Canadian sulphur, accounting for 20% of our exports, followed by Australia (10%), Brazil (8%), South Korea (5%), Morocco (5%), Western Europe (4%), Tunisia (4%) and South Africa (3%). Half of our exports of sulphur were delivered to six countries in 1989 compared to three countries in 1988, showing the important scattering of Canada's established market during this year. The re-emergence of China and the U.S.S.R. as buyers for Canadian sulphur in 1989 was offset by reduced shipments to Morocco. Small gains in sulphur exports were registered in North America (7%) with higher shipments to the United States (4%) and Mexico (15%), while significant reductions were reported for South America (-22%), Brazil (-18%) and Argentina (-60%). In Western Europe, lower shipments to France (-70%) were not offset by some gains in Belgium (+10%). Exports to Asia remained stable at 850 000 t as losses in South Korea were replaced by gains in India and Indonesia. China's and the U.S.S.R.'s re-entry into the marketplace was beneficial for Canadian suppliers which sold close to 515 000 t in these countries. Shipments to Israel and Oceania increased 30% and 10% respectively. In Africa, Morocco's purchases dropped 85% while shipments to Tunisia and South Africa both decreased by about 60%.

During 1989, some sulphur was poured into inventories; however, the withdrawal was in the order of 0.7-0.8 Mt compared to 2.2 Mt in

1988. Stockpiles at year-end were estimated to contain 4.2 Mt. About 90% of these sulphur stocks were spread amongst 18 plants, mainly northwest of Calgary in Alberta. Six sites each held 250 000 t and more. The largest inventory block at Husky's Ram River plant has more than 1.0 Mt.

On the domestic scene, the industry's developments were dominated by competition between Shell Canada Limited and Husky Oil Ltd. in the bidding for the development of the Caroline gas field. Discovered by Shell in 1986, the Caroline gas field is the largest reservoir found in Alberta in 20 years. During 1989, Husky withdrew its support to the plan proposed by the Caroline Area Gas Development Group which backed the "selected development option" in a three-phase project: expansions at Husky's Ram River and Gulf Canada Limited's Strachan plants and the construction of a new 2600 t/d sulphur-processing plant near James River. Husky proposed a $660 million "plant expansion option" which included the construction of a transmission station near the field, a 54 km sour gas (43% H_2S) pipeline to Ram River and a plant expansion for the existing facilities currently operating at 56% of capacity. This plan would permit recovery of close to 6620 t/d of sulphur. No modifications are expected for sulphur-handling facilities which have a 7800 t/d design capacity. Shell Canada Limited announced another plan - "the new plant option" - to construct a single $700 million gas processing plant, 14 km south of Caroline, and a 40 km underground pipeline to carry liquid sulphur to Shantz, a nearby forming plant and a railhead for exports. The new gas processing plant would have a design production capacity of 1.4 Mt/y of sulphur. Shell heads a consortium which owns more than 80% of the natural gas reservoir estimated at 56 billion m^3 of sour gas (30-35% H_2S). Close to 25 Mt of sulphur reserves were estimated. Both companies are seeking approval of their plans by the Energy Resources Conservation Board (ERCB) in the spring of 1990 for construction to start by mid-year and for completion during 1993.

Shell Canada Limited, Mobil Oil Canada, Ltd., PanCanadian Petroleum Limited and Norcen Energy Resources Limited began field construction work at the $65 million Bearberry demonstration pilot project to extract sulphur from super sour gas (90% H_2S). The 204 t/d liquid sulphur plant is due for completion by the fall of 1990. The five-year project, if successful, could lead to a commercial development for 3500 t/d of sulphur for 25 years, starting between 1995 and 1997. Reserves of sulphur have been estimated to be between 70 and 100 Mt.

Consumers' Co-operative Refineries Limited ran into several start-up problems at its new $680 million heavy oil upgrader near Regina, Saskatchewan. The facility worked at 25% of capacity due to a succession of mechanical problems and accidents, the most serious being a fire in the pre-heater of the Atmospheric Residual Sulphurization Unit in June. The upgrader remained shut down while the refinery operated intermittently during the second half of 1989. The operation will resume in January 1990. Sulphur recovery capacity expanded during the construction from 9000 t/y to 85 000 t/y.

Husky Oil Operations Ltd. confirmed its full commitments to the $1.27 billion heavy oil upgrader to be built at Lloydminster, Saskatchewan. During 1989, several other mega-projects like OSLO and Hibernia suffered delays and cutbacks, and remained in planning stages; the Lloydminster project was on schedule for completion by 1992. A sulphur recovery unit would produce up to 70 000 t/y of elemental sulphur from residual gas generated from the upgrading process.

Esso Resources Canada Limited continued its field work to tap the Obed sour natural gas field (25% H_2S) near Edson, Alberta. Sulphur reserves were estimated at 4 Mt. The sour gas is to be pipelined to Chevron Standard Limited's Kaybob III plant for processing. The incremental sulphur production from Obed is expected by mid-1990 and would range between 300 000-350 000 t/y.

Petro-Canada Inc. completed the $66 million expansion project at the Brazeau River natural gas processing plant in Alberta. The expansion is expected to come on-stream in the first quarter of 1990. The capacity of sulphur production is to increase threefold to reach 100 000 t/y. The firm also announced its intention to phase out sulphur recovery at its oil refinery in Port Moody, British Columbia; the plant had a design capacity to recover close to 9000 t/y of sulphur.

Husky Oil Ltd. suffered some technical problems at its natural gas plant in Ram River, Alberta, during February. The severe frost conditions occasioned production delays that lasted one month, reducing its overall sulphur output for 1989.

Pacific Coast Terminals Co. Ltd. completed the installation of a new rotary rail car unloading and conveying system in British Columbia. The new unit complements the Stake Rake system installed during 1987. The new dumping facility has a capacity of 3000 t/h of sulphur and permits routing to either ground storage or directly to shiploading.

During the year, several developments occurred in the oil and gas industry that impacted on the sulphur sector. Early in 1989, Esso Resources Canada acquired the assets of Texaco Canada Inc.; the completion of the merger is pending final approval from Investment Canada. Esso also postponed its decision to join Cansulex Limited. Amoco Canada Resources Ltd. announced its intention to phase out Dome Petroleum Limited's membership from Cansulex Limited effective January 1991. Several plans for new sour gas facilities were announced in Alberta by Coho Resources Limited near McGregor Lake, Norcen Energy Resources Limited near St. Albert, and Unocal Canada Limited in the Beaverlodge area, but the latter project was rejected by the ERCB in the fall of 1989.

Sulphuric Acid

In 1989, the market for sulphuric acid remained firm with sustained performance in the titanium dioxide, aluminum and fertilizer sectors and some slow-downs in the pulp and paper sector. The production of sulphuric acid from smelters was estimated at 2.36 Mt, a 3% decline from 1988. The apparent consumption for sulphuric acid in Canada was estimated at close to 3 Mt of which 45% was acid produced from sulphur-burning operations. Agricultural chemicals accounted for half of the sulphuric acid consumption, followed mainly by inorganic chemicals (20%), uranium mining (12%) and pulp and paper (9%).

Noranda Minerals Inc. completed the construction of its $160 million sulphuric acid plant at the Horne copper smelter in Rouyn-Noranda, Quebec. The plant will allow Noranda to cut sulphur dioxide (SO_2) emissions by up to 70% by 1993. The 350 000-400 000 t/y acid plant will produce three different grades: 93%, 96% and 98%. Production of marketable acid grades is expected in the spring of 1990. The company was required, under government regulations, to reduce SO_2 emissions by 50% to 276 000 t/y by 1994.

Westcoast Energy Inc. commissioned the $8 million expansion at its chemical plant in Prince George, British Columbia early in 1989. The plant, which was acquired from C-I-L Inc. last year, has expanded its capacity to produce 30 000 t/y of liquid sulphur dioxide and 45 000 t/y of sulphuric acid.

Inco Limited continued engineering work on its $494 million project announced last year for curbing SO_2 emissions at the Sudbury nickel smelter in Ontario. Inco is to complete the construction of the first of two flash furnaces and a new acid plant by late 1991. SO_2 emissions are expected to be cut by 60% to 265 000 t/y by 1994. The plans call for maximizing sulphur rejection as pyrrhotite in the milling process, and producing strong SO_2 gas from the flash furnaces for conversion into acid. The production of sulphuric acid is likely to increase by 100 000 t/y by 1994.

Hudson Bay Mining and Smelting Co., Limited (HBMS) is expected to propose plans to meet government objectives for cutting total SO_2 emissions by 25% by 1994 at its copper and zinc smelting operation in Flin Flon, Manitoba.

Ontario Hydro approved plans to reduce acid rain pollution. A $1.3 billion project was announced and called for the installation of eight scrubbers at the coal-fired generating stations in Lambton and Nanticoke between 1994 and 1998. The scrubbers will use a wet limestone process for reducing emissions by 40 to 60%. By-product gypsum wastes will be produced and used in part in the manufacture of cement and wallboards.

C-I-L Inc. of North York, Ontario sold its sulphur products division to a former management group. The new firm, Marsulex Inc., will continue to market sulphuric acid, sulphur dioxide and sulphur in North America.

WORLD DEVELOPMENTS

Elemental Sulphur

In 1989, expectations for a tight market and sustained price increases for sulphur fell apart when a trade dispute started between Morocco (a major sulphur buyer and producer of phosphoric acid) and India (a major consumer of phosphoric acid); the disagreement over sales contracts started in February and lasted ten months, resulting in major disruptions in sulphur sales to Morocco and affecting important suppliers with the exception of the United States. Middle East producers have focussed their sales toward India while Poland and Mexico lost all sales to North Africa. Canada, the largest supplier of sulphur to Morocco over the last two years, incurred a shortfall of close to 1.5 Mt in export volumes compared to 1988. On the positive side, the U.S.S.R. and China re-entered the marketplace with combined imports totalling close to 515 000 t supplied by Canada.

In most regional markets, namely Africa, Asia and Latin America, the demand for sulphur was much below expectations and caused sharp competitions for market share and dramatic price erosions during 1989. At the beginning of the year, several buyers carried high levels of sulphur and phosacid inventories, increasing the severity of the inpact of the dispute on sulphur requirements. Consumption of sulphur dropped in Morocco, Tunisia and Brazil. However, the North American demand remained strong as U.S. producers of fertilizers were able to sell on the domestic market and in Asia.

Producers' stockpiles remained virtually unchanged over 1989 as withdrawals reported in Canada and France were offset by additions to inventories in Saudi Arabia and the United States. World sulphur inventories by year-end were estimated at 9.2 Mt; a slight reduction was achieved due to some withdrawals from Iraq, re-emerging as a significant world supplier.

United States

The United States was the world's largest sulphur producer as well as a major Frasch producing country. Production of elemental sulphur rose 10% to 10.55 Mt of which recovered sulphur from oil and gas processing plants accounted for two thirds. Most of the increase was from higher output from Frasch. Other-forms-of-sulphur (i.e. acid) increased 4% to 1.17 Mt and accounted for 10% of overall sulphur-in-all-forms production. In 1989, sulphur was produced at 175 plants operating in 32 states. Apparent consumption remained flat at 12.7 Mt for use mostly in fertilizers (70%), chemicals (12%) and petroleum refining (8%). Exports dropped 370 000 t to 1.22 Mt, while imports, mainly from Mexico and Canada, rose 13% to 2.3 Mt. Major export destinations were Western Europe, Brazil and Mexico; losses in sales were reported in Brazil and Mexico when compared with 1988. With lower export levels in 1989, producers poured close to 400 000 t of sulphur in blocks, to reach 1.5 Mt by year-end. Texasgulf Inc. suspended production at its Commanche Creek Frasch mine in Texas during November; the 365 000 t/y sulphur operation was recommissioned last year but the lower sulphur prices in 1989 resulted in mothballing the facility for an indeterminate period. Freeport-McMoRan Resource Partners, Ltd. announced in early 1989 a massive sulphur discovery at Main Pass Block 299, 30 km offshore of the mouth of the Mississippi River in the Gulf of Mexico. Geologic sulphur reserves have been estimated at 68 Mt, grading 28% at depths ranging between 450-560 m. Plans for sulphur production call for an operation with a 3 Mt/y nameplate capacity to come on-stream by 1992-93. Mitsubishi Chemical Industries Ltd. of America announced its plans for a new copper smelter near Houston, Texas; acid production is expected to range between 400 000 and 450 000 t/y by 1992. In the summer of 1989, a new Clean Air Act was proposed by the Bush Administration to curb acid rain by the year 2000. The program aims to cut SO_2 emissions, with a first phase reduction of five million short tons by 1995 and a further five million short tons by the year 2000. Reductions would be mainly from primary coal-fired electric utilities and nonferrous smelters. Close to four million short tons of acid rain precursors flow into Canada, of which 90% comes from power plants located in the Ohio River Valley.

U.S.S.R.

The U.S.S.R. remained the world's second largest producer of brimstone; however, during 1989, several technical problems were reported at Astrakhan plants, resulting in much lower output than expected. Environment and technical problems plagued Astrakhan I, commissioned in 1987; Astrakhan II, due for completion in late 1989; and Orenburg. The operating rate at Astrakhan I was reported at less than 50% in the first half, and continued to decline until the plant was shut down at year-end. Construction work at Astrakhan II was put on hold until problems are solved; its completion has been postponed to 1991. Meanwhile, the oil-related project at Tenghiz I is expected to come on-stream in 1991 (with an eventual capacity of 460 000 t/y of sulphur). Plants at Tenghiz II and III could be operating by 1992. The multi-stage Tenghiz development has been planned with six incremental 500 000 t/y phases which would bring close to 3 Mt/y of sulphur capacity on-stream in 1998. Commitments for forming and handling sulphur at Astrakhan were put on hold; any exports of granular sulphur are likely to be realized only after 1993. During 1989, the U.S.S.R. re-entered the marketplace to meet its domestic sulphur requirements. On a nine-month basis, the U.S.S.R. imported 820 000 t of sulphur, a 50% increase over the same period last year, of which 23% was from Canada and the rest from Poland. The technical problems encountered in 1989 have cast more doubt on the capacities of the U.S.S.R. to bring large volumes of sulphur into the open market by 1993. However, the continuing importance of oil and gas production in the U.S.S.R. will likely reinforce its resolve to develop these fields, albeit with a postponement of a few years. Difficult logistics may hinder the U.S.S.R.'s capability to market its sulphur abroad, but possible swap arrangements with Poland may, in part, alleviate those problems. Over the next decade, the domestic consumption of sulphur for industrial and fertilizer usages is expected to increase, resulting in a longer-than-expected delay to reach the marketplace. However, the need for hard currencies might cause some reversal in its allocation plans.

Poland

Poland remained the second largest exporter of elemental sulphur after Canada. Production in 1989 was relatively stable at 4.8-4.9 Mt. Frasch sulphur was mined at Jeziorko, Grzybow and Machow. Production difficulties were reported late in 1989 at Grzybow. Construction work at Oziek has suffered some delays due to environmental constraints; its development is projected in two phases: Stage I for a 500 000 t/y design capacity to be operational by 1992, followed by Stage II for a 700 000 t/y capacity addition due for completion by 1995. The new mine was planned to offset the depletion of reserves at Grzybow and Machow. In 1989, domestic consumption was estimated at 1.1 Mt and is forecast to increase slightly in 1990 with the commissioning of a new fertilizer plant. Poland exported 80% of its production, mainly to Eastern Europe (52%), Western Europe (23%), Brazil (10%), India (6%) and North Africa (5%).

Mexico

Mexico produced close to 2.0 Mt of sulphur in 1989, of which 85% was Frasch. Production is expected to increase in 1990 with an improving recovery rate at Otapan. This new mine was commissioned in 1988 with a design capacity of 550 000 t/y; it will replace the anticipated depletion of the Jaltipan Frasch mine. Recovered sulphur production from oil and gas is forecast to increase 10% by next year. Domestic consumption declined 6% to 1.1 Mt. Mexico exported solid and liquid sulphur from the Gulf coast, mostly to the United States. A 30% drop in export sales during 1989 resulted mostly from lower exports to Morocco.

Saudi Arabia

In Saudi Arabia, sulphur production has been estimated at 1.5 Mt, a 4% increase over 1988. Close to 85% came from natural gas processing at Uthmaniyah, Shedgum and Berri, while the remainder was recovered from oil refineries. Exports dropped 30%, with major losses in North Africa and India. India, Morocco, Tunisia and Italy remained the main shipment destinations. Stockpiles at Berri were estimated at close to 2.0 Mt late in 1989, a 0.4 Mt increase over 1988. Saudi Arabia now has the availability of two 500 t/d melters that could be used for withdrawals as required. Many changes occurred in the marketing structure for Saudi sulphur; the responsibility was transferred to Samarec in Jeddah. This change was followed by a new pricing policy for a variable Government Established Price (GEP). In 1989, a tentative two-tier pricing strategy was tested and dropped due to the rapid decline in world prices. Aggressive contract agreements were reached at year-end with its major customers and should result in supplementary re-melts and higher export levels during 1990.

Iraq

Iraq, ranked as the sixth major world producer of brimstone, mostly extracted from the Mishraq Frasch mine; sulphur is also recovered from two natural gas plants at B'aiji and Kirkuk. Production in 1989 was estimated at 1.2 Mt, a 10% increase over 1988. Several expansion plans were announced for 1991-92. Mishraq capacity is planned to double to reach 2.1 Mt/y by the end of 1991, and Kirkuk's capacity is forecast to reach 500 000 t/y by 1992. Filtering equipment will be installed to upgrade the quality of reclaimable sulphur from Mishraq. In 1989, exports were shipped to North Africa and the Middle East; Iraq made several inroads in the Moroccan and Tunisian markets and is expected to emerge as a significant supplier in the 1990s.

PRICES

Contract prices for offshore exports of elemental sulphur from Vancouver declined 20% during 1989. Quotations for contract prices (f.o.b. Vancouver) started at US$98-105/t in January with expectations for some increases early in the first half. Suppliers achieved a US$9/t increase to shift prices in the range of US$107-116/t. However, the trade dispute between Morocco and India depressed the international sulphur market and resulted in a sharp price erosion. The market resisted major changes up to June, when hopes for a quick settlement faded out. Prices then started to fall rapidly and bottomed out at US$77-86/t by year-end.

Despite a strong demand in North America, price indications for liquid sulphur (f.o.b. Alberta) parallelled international trends and decreased 25% to US$45-50/t late in 1989.

During the first half of 1989, the spot market remained optimistic and kept a favourable premium over contract prices. Spot prices (f.o.b. Vancouver) ranged between US$114-126/t up to June. Afterward, spot prices dropped drastically and kept in line with contract quotations at US$77-85/t; late in 1989, prospects for a tighter market in 1990 led to some upward movements in spot prices.

Sulphuric acid prices in Canada increased 10% to $122/t. A slight correction by the end of the year was expected due to depressed sulphur prices and lower operating rates in the pulp and paper sector.

USES

About 60% of all of the sulphur consumed in the world is used in the production of fertilizers such as superphosphates, ammonium phosphate and ammonium sulphate. The second largest consuming sector is the chemical industry where sulphur is used in products ranging from pharmaceuticals to synthetic fibres in plastics and petroleum catalysts. Other consumers of sulphur include the manufacturers of titanium dioxide used in paint, enamels, paper and ink; iron and steel; and nonferrous metals. These consuming industries use sulphur in the form of sulphuric acid which accounts for almost 90% of total sulphur consumption (60% of sulphuric acid consumption is in fertilizers). Products requiring sulphur in the non-acid form include insecticides and fungicides, pulp and paper, photography, leather processing, rayon and rubber.

OUTLOOK

The settlement of the ten-month contract dispute between Morocco and India late in 1989 is expected to boost a fairly depressed market into a reasonably balanced condition during 1990. The resumption of phosphoric acid production to normal levels will secure better sales for sulphur suppliers, especially for Canadian producers. The expectations for higher consumption of sulphur in North Africa and for the continuation of delays in reactivating the Astrakhan projects will require remelts for supplementing production during 1990. Expectations of a firmer marketplace has led to anticipated increases in prices during the first quarter of 1990. Trade movements are expected to intensify with the rapid emergence of Middle East producers as more significant suppliers in the contract market.

In Canada, production of natural gas is forecast to continue to rise for the next three years due to a strong demand for natural gas in the United States; soft gas prices and improved access to U.S. pipelines will allow some growth in gas exports and should exceed the growth of Canadian demand. During this period, sulphur output is likely to increase as recovery starts from Caroline, Obed and gas projects in northeast British Columbia. With a declining sulphur-to-gas ratio in established fields, new sulphur extraction will come from deeper and more sour natural gas reserves. Elemental sulphur production in Canada has been forecast to increase by 28% to reach 7.7 Mt by 1995. High shipment levels will continue to be met from production output and re-melts. With the current inventory levels at 4.2 Mt, the availability of stocks may be limited to two more years; by 1992, its marketability will be quite restricted for reasons of logistics, contamination and reclamation economics.

Incremental production of sulphur-in-other-forms will come on-stream during the 1990s as stringent environmental regulations will limit the levels of SO_2 emissions from nonferrous smelters and coal-fired power stations. Canadian production capacity for sulphuric acid is projected to increase 18% to 3.8 Mt/y between 1990 and 2000. Additional capacity for other sulphur products from smelters (brimstone and sulphur dioxide) will be more related to market demand and is expected to augment by 30%.

With a predominant position as the world's major sulphur exporter during the last decade, Canada enters into the 1990s with potential to maintain a strong presence in the world trading of sulphur. Canada will continue to dispose of huge amounts of assured supplies of involuntary sulphur. Canadian suppliers have established an efficient logistic system to meet world requirements. However, the role of Canada as a swing supplier may fade away with the rapid depletion of its inventories.

The forecast for the world sulphur market calls for a relatively balanced market in the short term while experiencing some softness by the early to mid-1990s. On the supply side, large additional sulphur supplies will be brought on-stream from the commissioning of new, large-scale projects in Canada (Caroline), the United States (Main Pass), the Middle East (Mishraq) and the U.S.S.R. (Tenghiz). Technical problems at Astrakhan are likely to be solved within the next three years. By 1995, world elemental sulphur production is forecast to increase to about 46 Mt. Trade patterns are expected to evolve as well with the emergence of higher availability from sulphur-in-other-forms as incremental smelter acid tonnages would likely continue to compete with established brimstone sales in regional markets, especially in North America and Western Europe.

Sulphur demand is forecast to grow steadily at a 2% annual rate during the period 1988 to 1995. Sulphur consumption in fertilizers is expected to be strong in developing countries in Latin America, Asia and Africa, while it will remain stable in North America and Oceania. Some decline is anticipated in Western Europe while demand in Eastern Europe should show some increase. Consumption in industrial uses is forecast to grow at a much slower pace than that for fertilizer usages. By the year 1995, industrial uses are forecast to account for 40.5% of world demand for sulphur-in-all-forms, a 1.3% decrease from 1988.

The increasing concerns over the quality of the environment are likely to impact on the world sulphur industry. On the supply side, further environmental regulations will result in the additional recovery of SO_2 emissions from industrial sources while recovered sulphur production, in the form of brimstone and sulphuric acid, is expected to increase; however, some expansions may be delayed, as is currently the case in Poland, the U.S.S.R. and Canada. On the demand side, stricter controls over effluents contamination by spent acid would likely reduce or cut the consumption of sulphur in some industrial usages such as in the pulp and paper, titanium dioxide and detergents sectors. It is expected that new technologies will be developed to meet these challenges as well as those associated with improving the safe transportation of sulphur products.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2503	Sulphur of all kinds, other than sublimed sulphur, precipitated sulphur and colloidal sulphur				
2503.10.00	- Crude or unrefined sulphur	Free	Free	Free	Free
2503.90.00	- Other	Free	Free	Free	Free
2802.00.00	Sulphur, sublimed or precipitated; colloidal sulphur	Free	Free	Free	Free
2807.00.00	Sulphuric acid; oleum	Free	Free	Free	Free
2811.23.00	-- Sulphur dioxide	Free	Free	Free	3.3%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, SULPHUR SHIPMENTS AND TRADE, 1988 AND 1989

		1988		1989^{p}	
		(tonnes)	($000)	(tonnes)	($000)
Shipments[1]					
Sulphur in smelter gases[2]		856 496	85 179	831 246	83 048
Elemental sulphur[3]		8 106 641	601 756	6 520 262	554 353
Total sulphur content		8 963 137	686 935	7 351 508	637 401
Imports				(Jan.-Sept.)	
2503.10	Sulphur, crude or unrefined				
	United States	7 178	1 162	1 356	307
	Total	7 178	1 162	1 356	307
2503.90	Sulphur, n.e.s.				
	United States	14 500	3 200	14 212	1 359
	Japan	9 098	255	-	-
	France	1 141	35	-	-
	Total	25 039	3 490	14 212	1 359
2802.00	Sulphur sublimed or precipitated; colloidal sulphur				
	United States	2 189	595	1 326	492
	Other countries	125	74	48	45
	Total	2 314	669	1 373	537
2807.00	Sulphuric acid; oleum				
	United States	30 008	2 861	20 654	2 045
	Spain	10 143	612	-	-
	Other countries	76	7	35	3
	Total	40 227	3 480	20 689	2 049
2811.23	Sulphur dioxide				
	United States	1 495	500	426	141
	Total	1 495	500	426	141
Exports					
2503.10	Sulphur, crude or unrefined				
	Morocco	1 895 960	235 360	207 419	23 024
	United States	945 581	80 273	777 422	64 137
	Australia	527 968	62 259	412 291	51 401
	Brazil	510 594	63 826	321 614	41 479
	Tunisia	474 432	56 299	160 665	16 605
	South Africa	468 015	57 914	133 882	16 331
	South Korea	462 945	55 550	207 985	26 432
	Mexico	274 137	37 437	163 938	23 052
	Indonesia	235 093	28 300	203 509	27 132
	Israel	209 103	24 155	172 660	20 416
	France	207 576	25 799	45 131	5 018
	Taiwan	168 499	21 706	129 484	15 973
	Other countries	853 241	103 429	981 976	113 600
	Total	7 233 144	852 307	3 917 976	444 600

TABLE 1. (cont'd)

		1988		Jan.-Sept. 1989[p]	
		(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)					
2503.90	Sulphur, n.e.s.				
	United States	123 202	10 938	31 387	1 208
	New Zealand	20 500	2 530	-	-
	Other countries	3 650	488	6 967	984
	Total	147 352	13 956	38 354	2 194
2802.00	Sulphur, sublimed or precipitated; colloidal sulphur				
	United States	2 526	369	258	58
	South Korea	1 000	721	-	-
	Total	3 256	1 090	258	58
2807.00	Sulphuric acid; oleum				
	United States	849 262	28 221	492 144	17 887
	Other countries	119	87	163	29
	Total	849 381	28 308	492 307	17 916
2811.23	Sulphur dioxide				
	United States	52 642	6 230	59 247	6 710
	Other countries	1	5	-	-
	Total	52 643	6 235	59 247	6 710

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] Data compiled regardless of origin (i.e. domestic and foreign source materials). [2] Sulphur in liquid SO_2 and H_2SO_4 recovered from the smelting of metallic sulphides and from the roasting of zinc-sulphide concentrates. [3] Producers' shipments of elemental sulphur produced from natural gas; also included are small quantities of sulphur produced in the refining of domestic crude oil, synthetic crude oil and remelts from vatted stocks.

[p] Preliminary; n.e.s. Not elsewhere specified; - Nil.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, SOUR GAS AND OIL SANDS SULPHUR EXTRACTION PLANTS, 1987-89

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Sulphur Capacity		
			1987	1988	1989
	(Alberta, except where noted)	(percent)		(tonnes)	
Sour Gas					
Alberta Energy Company Ltd.	Sinclair - Hythe	3	256	256	256
Amerada Hess Corporation	Garrington - Olds	15	389	389	389
Amoco Canada Petroleum Company Ltd.	Bigstone Creek	16	382	385	385
Amoco Canada Petroleum Company Ltd.	Caroline-Garrington	n.r.	-	-	10.4
Amoco Canada Petroleum Company Ltd.	East Crossfield-Elkton	34	1 797	1 797	1 797
Amoco Canada Petroleum Company Ltd.	Windfall - Whitecourt	21	1 330	1 330	1 330
Canadian Occidental Petroleum Ltd.	East Calgary-Crossfield	17	1 696	1 696	1 696
Canadian Occidental Petroleum Ltd.	Okotoks (Mazeppa)	36	577	577	577
Canadian Occidental Petroleum Ltd.	Okotoks	34	431	431	431
Canadian Occidental Petroleum Ltd.	Paddle River	0.1	19	19	19
Canadian Superior Oil Ltd.	Harmatten-Elkton-Leduc	46	490	490	490
Canadian Superior Oil Ltd.	Lone Pine Creek	10	157	157	157
Chevron Standard Limited	Kaybob South III	16	3 557	3 557	3 557
Dome Petroleum Limited	W. Pembina	n.r.	300	340	340
Esso Resources Canada Limited	Joffre	3.4	17	17	23.5
Esso Resources Canada Limited	Quirk Creek	9	299	299	299
Esso Resources Canada Limited	Redwater	2.6	11	11	11
Gulf Canada Limited	Homeglen-Rimbey	1	128	128	128
Gulf Canada Limited	Nevis	4	197	197	197
Gulf Canada Limited	Strachan	9	943	953	953
Gulf Canada Limited	Hanlan Robb	9	1 092	1 092	1 092
Home Oil Company Limited	Carstairs	0.5	65	65	65
Hudson's Bay Oil and Gas Company Limited (HBOG)	Brazeau River	0.8	110	110	110
Hudson's Bay Oil and Gas Company Limited (HBOG)	Caroline	0.8	8	8	8
Hudson's Bay Oil and Gas Company Limited (HBOG)	Edson	1.4	288	289	289
Hudson's Bay Oil and Gas Company Limited (HBOG)	Kaybob South I	11	1 086	1 086	1 086
Hudson's Bay Oil and Gas Company Limited (HBOG)	Kaybob South II	16	1 086	1 086	1 086
Hudson's Bay Oil and Gas Company Limited (HBOG)	Lone Pine Creek	10	283	283	283
Hudson's Bay Oil and Gas Company Limited (HBOG)	Sturgeon Lake	9	98	98	98

TABLE 2. (cont'd)

Operating Company	Source Field or Plant Location	H_2S in Raw Gas	Daily Sulphur Capacity		
			1987	1988	1989
	(Alberta, except where noted)	(percent)		(tonnes)	
Hudson's Bay Oil and Gas Company Limited (HBOG)	Zama	8	74	74	74
Husky Oil Ltd.	Brazeau River-Nordegg	1.3	42	42	42
Husky Oil Ltd.	Rainbow Lake	2	139	139	139
Husky Oil Ltd.	Ram River (Ricinus)	19	4 572	4 572	4 572
Mobil Oil Canada, Ltd.	Wimborne	13	182	182	182
Mobil Oil Canada, Ltd.	Teepee	8	30	30	30
Norcen Energy Resources Limited	Minnehik-Buck Lake	0.1	45	45	45
Petro-Canada Inc.	Brazeau	7	80	444	444
Petro-Canada Inc.	Gold Creek	3	43	43	43
Petro-Canada Inc.	Wildcat Hills	4	177	177	280
Saratoga Processing Company Limited	Savannah Creek (Coleman)	24	389	389	389
Shell Canada Limited	Caroline-Bearberry	90	–	–	228
Shell Canada Limited	Burnt Timber Creek	13	489	489	489
Shell Canada Limited	Innisfail	16	163	163	163
Shell Canada Limited	Jumping Pound	6	597	597	597
Shell Canada Limited	Progress	0.7	15	15	15
Shell Canada Limited	Rosevear	8	171	171	171
Shell Canada Limited	Simonette River	16	95	95	95
Shell Canada Limited	Waterton	19	3 107	3 107	3 107
Suncor Inc.	Rosevear	8	110	110	110
Texaco Exploration Company	Bonnie Glen	0.4	12.5	12.5	12.5
Westcoast Energy Inc.	Fort Nelson, B.C.	n.r.	1 100	1 100	1 100
Westcoast Energy Inc.	Taylor Flats, B.C.	3	460	460	460
Westcoast Energy Inc. (Hasler Flats), B.C.	Pine River	n.r.	1 055	1 055	1 055
Western Decalta Petroleum (1977) Limited	Diamond Valley	2.5	11	11	24
Oil Sands					
Suncor Inc.	Mildred Lake	n.a.	441	441	441
Syncrude Canada Ltd.	Fort McMurray	n.a.	1 155	1 255	1 255

Sources: Alberta Energy Resources Conservation Board publications, October 1989; Oilweek, January 1987, 1988 and 1989.

r Revised; n.a. Not applicable; n.r. Not reported; – Nil.

TABLE 3. CANADA, PETROLEUM REFINERY SULPHUR CAPACITIES, OPERATING IN 1987–89

Operating Company	Location	Daily Capacity		
		1987	1988	1989
			(tonnes)	
Canadian Ultramar Limited	St. Romuald, Quebec	40[1]	40[1]	40[1]
Chevron Canada Limited	Burnaby, British Columbia	10	10	10
Consumers' Co-operative Refineries Limited	Regina, Saskatchewan	16	16	151
Imperial Oil Limited	Dartmouth, Nova Scotia	76	76	76
	Edmonton, Alberta	40	40	40
	Port Moody, British Columbia	20	20	20
	Sarnia, Ontario	140	140	140
Irving Oil Limited	Saint John, New Brunswick	100	100	100
Petro-Canada Products Inc.	Clarkson-Mississauga, Ontario	41	41	41
	Edmonton, Alberta	56	56	56
	Oakville-Trafalgar, Ontario	41	51	51
	Port Moody, British Columbia	25	25	0[2]
Shell Canada Limited	Burnaby, British Columbia	15	15	15
	Sarnia, Ontario	35	35	35
	Scotford, Alberta	14	14	14
Sulconam Inc.	Montreal, Quebec	300	300	300
Suncor Inc.	Sarnia, Ontario	50	50	50
Texaco Canada Inc.	Nanticoke, Ontario	35	35	35
Total effective capacity[3,4]		1 101	1 101	1 225

Sources: Oilweek; Mineral Policy Sector, Energy, Mines and Resources Canada.

[1] 42 kt/y capacity on stand by at St. Romuald, Quebec. [2] Port Moody, British Columbia, sulphur processing unit shut down in 1989. [3] Husky Oil Ltd. refinery at Prince George did not produce sulphur for at least the last five years. [4] Effective capacity comprising production capacity where sulphur output where reported in the last five years.

TABLE 4. CANADA, PRINCIPAL SULPHUR DIOXIDE AND SULPHURIC ACID PRODUCTION CAPACITIES, 1989

Operating Company	Plant Location	Raw Material	Annual capacity Liquefied SO_2	 Sulphuric acid[1]	 Sulphur equivalent[2]
				(000 t)	
Brunswick Mining and Smelting Corporation Limited	Belledune, N.B.	SO_2 lead zinc		176	58
Canadian Electrolytic Zinc Limited (CEZ)	Valleyfield, Que.	SO_2 zinc conc.		430	140
C-I-L Inc.	Beloeil, Que.	elem sulphur		65	21
Falconbridge Limited	Sudbury, Ont.	SO_2 nickel conc.		355	116
Gaspé Copper Mines, Limited	Murdochville, Que.	SO_2 copper		135	44
Noranda Minerals Inc.	Rouyn-Noranda ,Que.	SO_2 copper		400	131
Inco Limited	Copper Cliff, Ont.	SO_2 pyrrhotite and nickel conc.		550	180
	Copper Cliff, Ont.	SO_2 copper conc.	100	-	50
Falconbridge Limited	Kidd Creek, Ont.	SO_2 zinc conc.		220	72
	Kidd Creek, Ont.	SO_2 copper conc.		340	111
NL Chem Canada Inc.	Varennes, Que.	elem sulphur		56	18
Sub-total, Eastern Canada			100	2 727	941
Border Chemical Company Limited	Transcona, Man.	elem sulphur		150	49
Marsulex Inc.	Fort Saskatchewan, Alta.	elem sulphur		150	49
Westcoast Energy Inc.	Prince George, B.C.	elem sulphur	30	45	30
Cominco Ltd.	Trail, B.C.[3]	SO_2 zinc & lead conc.	75	430	206
Eldorado Resources Limited	Rabbit Lake, Sask.	elem sulphur		72	23
Esso Chemical Canada	Redwater, Alta.	elem sulphur		910	297
Key Lake Mining Corporation (KLMC)	Key Lake, Sask.	elem sulphur		72	23
Sherritt Gordon Limited	Fort Saskatchewan, Alta.	elem sulphur		233	75
Sulco Chemicals Limited	Elmira, Ont.	elem sulphur		33	11
Sub-total, Western Canada			105	2 130	773
Total			205	4 857	1 714

Source: Mineral Policy Sector, Energy, Mines & Resources; Canadian company interviews December 1988.

[1] 100% H_2SO_4. [2] Elemental sulphur equivalent of sulphuric acid is 32.7% and sulphur equivalent of liquefied SO_2 is 50%. [3] Cominco operation at Trail also has a 28 000 t/y production capacity for elemental sulphur, which has been added to the total sulphur equivalent production capacity of Cominco.

TABLE 5. CANADA, SULPHUR SHIPMENTS AND TRADE, 1970, 1975 AND 1980-89

	Shipments[1]				Imports[2]	Exports[2]
	Pyrites	In Smelter Gases	Elemental Sulphur	Total	Elemental Sulphur	Elemental Sulphur
			(tonnes)			
1970	159 222	640 360	3 218 973	4 018 555	48 494	2 711 069
1975	10 560	694 666	4 078 780	4 784 006	14 335	3 284 246
1980	14 328	894 732	7 655 723	8 564 783	1 767	6 850 143
1981	5 000	783 000	8 018 000	8 806 000	4 633	7 309 216
1982	9 000	627 000	6 945 000	7 581 000	2 159	6 111 444
1983	-	678 286	6 631 123	7 309 409	2 365	5 670 275
1984	-	844 276	8 352 978	9 197 254	3 019	7 326 847
1985	-	822 359	8 102 163	8 924 522	3 167	7 848 380
1986	-	758 231	6 965 775	7 724 006	10 763	6 257 054
1987	-	783 115	7 322 791	8 105 906	24 711	6 571 800
1988	-	856 496	5 981 495	6 837 991	32 217	7 530 496
1989p	-	831 246	5 183 425	6 014 671	. .	. .

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] Shipment data compiled regardless of origin (i.e. domestic and foreign source materials). [2] Includes only elemental sulphur in a crude or refined form.

p Preliminary; - Nil; . . Not available.

TABLE 6. CANADA, SULPHURIC ACID PRODUCTION, TRADE AND APPARENT CONSUMPTION, 1970, 1975, AND 1980-88

	Production	Imports	Exports	Apparent Consumption
		(tonnes - 100% acid)		
1970	2 475 070	9 948	129 327	2 355 691
1975	2 723 202	154 020	225 402	2 651 820
1980	4 295 366	18 048	323 775	3 989 639
1981	4 116 860	82 495	337 518	3 861 837
1982	3 130 854	192 514	259 740	3 063 628
1983	3 686 427	126 573	273 204	3 539 796
1984	4 043 389	28 330	553 780	3 517 939
1985	3 890 092	17 306	744 732	3 162 666
1986	3 536 062	29 127	755 606	2 809 583
1987	3 436 977	44 623	803 178	2 673 422
1988	3 804 856	40 227	849 381	2 995 702

Sources: Statistics Canada; Energy, Mines and Resources Canada.

TABLE 7. WORLD PRODUCTION OF SULPHUR, 1986–88

	1986		1987		1988p	
	All-forms[1]	Elemental	All-forms	Elemental	All-forms	Elemental
	(000 tonnes)					
World Total	**56 842**	**36 071**	**58 973**	**37 299**	**61 394**	**39 400**
Western World	**36 627**	**25 476**	**36 813**	**25 799**	**38 194**	**26 855**
Western Europe	**7 806**	**3 379**	**7 784**	**3 438**	**7 838**	**3 441**
Finland	577	42	611	50	608	45
France	1 318	1 138	1 243	1 063	1 187	1 007
West Germany	1 924	1 276	1 936	1 293	1 980	1 294
Italy	700	230	681	241	722	280
Norway	261	12	242	12	201	8
Spain	1 406	25	1 226	25	1 355	30
Others	1 620	656	1 799	698	1 785	777
Africa	**1 005**	**120**	**1 119**	**185**	**1 157**	**195**
South Africa	814	110	908	175	900	185
Others	191	10	211	10	257	10
Asia, Middle East	**6 087**	**3 922**	**6 333**	**4 232**	**7 077**	**4 957**
Japan	2 541	998	2 476	1 020	2 563	1 090
Saudi Arabia	1 350	1 350	1 450	1 450	1 470	1 470
Others	2 196	1 574	2 184	1 762	3 044	2 397
Oceania	**235**	**36**	**255**	**44**	**315**	**50**
North America	**18 606**	**15 609**	**18 206**	**15 238**	**18 645**	**15 635**
Canada	6 619	5 750	6 729	5 876	6 919	6 017
United States	11 987	9 859	11 477	9 362	11 726	9 618
Latin America	**2 888**	**2 410**	**3 116**	**2 662**	**3 111**	**2 526**
Mexico	2 139	2 054	2 391	2 306	2 254	2 144
Others	749	356	725	375	857	382
Eastern Europe	**6 680**	**5 120**	**6 745**	**5 145**	**6 850**	**5 240**
Poland	5 068	4 900	5 100	4 930	5 175	5 004
Others	1 612	220	645	215	675	236
U.S.S.R.	9 820	5 205	10 640	6 025	11 305	6 965
China	3 515	270	4 575	330	4 840	340
Other countries[2]	200	0	200	0	205	0

Source: The British Sulphur Corporation Limited, 1989.

[1] All-forms includes elemental sulphur, sulphur contained in pyrites and contained sulphur recovered from metallurgical waste gases, mostly in the form of sulphuric acid. [2] Includes North Korea, Vietnam and Cuba.

p Preliminary.

TABLE 8. CANADA, SULPHURIC ACID, REPORTED CONSUMPTION BY END USE, 1986-88

	1986	1987r	1988p
		(tonnes)	
Agricultural chemicals and fertilizers	1 652 222	1 347 767	1 415 404
Industrial inorganic chemicals	435 501	446 687	528 750
Uranium mines	351 821	315 445	331 580
Pulp and paper	347 806	282 595	247 506
Nonferrous smelting and refining	129 922	129 022	141 918
Other mines, metal and nonmetal	30 105	39 055	38 353
Crude petroleum and natural gas	43 138	29 689	40 881
Leather and textile	22 220	22 442	21 480
Soap and cleaning compounds	16 482	15 159	17 901
Plastics and synthetic resins	9 138	9 718	9 322
Iron and steel mills	11 524	8 867	14 227
Electrical products	17 097	7 183	10 249
Food, brewery and distillery	6 871	5 276	6 251
Other end uses	48 636	137 212	167 449

Source: Reports from producing companies compiled by Mineral Policy Sector, Energy, Mines and Resources Canada.
p Preliminary; r Revised.

Talc, Steatite and Pyrophyllite

1989

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SUMMARY

Talc, when isolated as a pure mineral, is composed of 63.4% SiO_2, 31.9% MgO and 4.8% H_2O. However, as an industrial commodity, talc seldom approaches that chemical composition. Mineral impurities contributing to a divergence from the composition of pure talc and often appearing in talcose mixtures are tremolite, chlorite, dolomite, calcite, mica and magnesite. The combination of physical properties such as extreme softness and whiteness, a high fusion point, a low thermal and electrical conductivity, its hydrophobic and organophilic nature, and its chemical inertness, allows talc to be very versatile in its application. Talc products are found in the paint, pulp and paper, ceramic, cosmetic, plastics, chemical, rubber and construction products industries.

Pyrophyllite is a hydrous aluminum silicate containing, in its pure form, 66.7% SiO_2, 28.3% Al_2O_3 and 5.0% H_2O. The mineral possesses physical properties characteristic of talc and, as such, finds its way into similar applications. Major markets for pyrophyllite are associated with the ceramics, refractories and insecticides industries.

Reported Canadian consumption of ground talc was 70 584 t in 1988, representing an increase of 7% from 1987. That increase can be accounted for mainly by a greater use of talc in the pulp and paper sector. In 1988, that industry used 18.3% more talc, or 4400 t more, than in 1987. Pulp and paper consumed 40.6% of the reported 1988 talc consumption, asphalt roofing 30.3% and paint 9.5%. Industries such as ceramic, rubber, cosmetic, chemical, refractory, fertilizers and gypsum products consumed the remaining 19.6%.

Preliminary 1989 figures for Canadian shipments of talc, steatite and pyrophyllite show little change from those of 1988. Shipments for each of these two years have been approximately 146 000 t. However, in 1989, the average unit value for the three commodities (talc, steatite and pyrophyllite) put together decreased by $4 to $105/t.

Imports of crushed or powdered talc for the first nine months of 1989 increased by 16.7% to 33 769 t while exports declined by 20% to 29 896 t. These disappointing trade figures and the lower average unit value for shipments in 1989 reflect a stiff competition from U.S. producers, a competition which is particularly strong for the talc grade used by the pulp and paper industry where prices have dropped on average by 25% to $150/t during the last two years.

Talc is produced in Canada by three companies: Bakertalc Inc. located in Quebec, Canada Talc Limited located in Ontario and Luzenac Inc., which recently completed its acquisition of a Quebec-based operation originally called B.S.Q. Talc Inc. and an Ontario-based operation known for years under the name of Steetley Talc Inc. On the production side, no significant changes occurred in the Canadian talc industry since it was reviewed in 1987. Overall capacity estimated at 150 000 t/y, processes and product lines, remain almost unchanged. Pyrophyllite is produced in Newfoundland by one company, Armstrong World Industries Canada Ltd.

The 1988 world production of talc, steatite and pyrophyllite of 7.5 Mt was about the same as in 1987. The United States at 1.15 Mt and India, Brazil and Finland each producing 0.4 Mt/y were, in 1988, the four dominant producers in the western world. Major producing countries for pyrophyllite for the same period were Japan with more than 1 Mt/y and the Republic of Korea (South Korea) with 0.5 Mt. In North America, the production of pyrophyllite was around 100 000 t for the United States and between 40 000 and 50 000 t for Canada.

With an estimated future growth of 5%/y, talc used in plastics will experience the fastest growth in North America. In particular, producers are considering surface-treated talc, a product which is characterized by a relatively high profit margin, as a potential avenue for product diversification. A greater demand for talc in the pulp and paper industry may also be seen as a result of environmental pressures to recycle waste paper. A demand of 42 000 t for the year 2000 has been estimated by Energy, Mines and Resources' (EMR) recent survey of the pulp, paper and paperboard industry. This demand corresponds to a growth of about 4%/y.

In contrast to North America, talc is used extensively as a paper-making pigment in Europe to enhance the quality of paper. Since the technology is already in place, this area may represent an opportunity for Canadian producers. Presently, domestic producers supply the pulp and paper industry mainly with a talc utilized as a pitch control agent.

MINERALOGY AND GEOLOGY

Talc is a hydrous magnesium phyllosilicate represented by the chemical formula $Mg_3Si_4O_{10}(OH)_2$. Theoretically, the mineral is composed of 63.4% SiO_2, 31.9% MgO and 4.8% H_2O. In nature, talc is usually intimately associated with numerous other minerals such as dolomite, calcite, quartz and those of the serpentine and amphibole mineral groups. Its colour is characteristically pale green, grey or creamy white. It exhibits a pearly and greasy lustre and presents a soapy feel. Talc is valued mainly for its extreme whiteness and smoothness, its high fusion point, its low thermal and electrical conductivity, and its chemical inertness.

Talc is derived from the alteration (hydration) of non-aluminous magnesium silicate rocks in an intensive metamorphic environment. The most common host rocks for the formation of talc are dolomite and ultramafic rocks, but it can also be found associated with mafic igneous rocks and sedimentary rocks. The mineral occurs as veinlets, tabular bodies or irregular lenses.

Steatite or soapstone, the name used in previous EMR mineral yearbooks, is a massive, variety of talc containing varying quantities of mineral impurities such as chlorite, dolomite, calcite and quartz and minerals from the serpentine and amphibole groups. Due to its chemical inertness and hydrophobic properties, steatite is known for its durability.

Pyrophyllite is a hydrous aluminum silicate with the chemical formula $Al_2Si_4O_{10}(OH)_2$. Theoretically, it is made up of 28.3% Al_2O_3, 66.7% SiO_2 and 5.0% H_2O. The mineral is formed by the hydrothermal alteration of acid igneous rocks, predominantly those that are andesitic to rhyolitic in composition. It occurs in low- and medium-grade metamorphic rocks rich in aluminum. Pyrophyllite's physical properties are practically identical to those of talc and, for this reason, it finds industrial uses similar to talc.

CANADIAN PROFILE

Consumption

Reported Canadian consumption of ground talc increased by 7% from 1987 to 1988. That increase can mainly be accounted for by a greater use of the mineral by the pulp and paper industry. That industry consumed 18.3% more talc in 1988 or 4400 t more than in 1987. EMR's non-metallic mineral 1988 consumption survey shows that pulp and paper accounted for 40.6% of the reported talc consumption, asphalt roofing 30.3% and paint 9.5%. The remaining 19.6% was used by the ceramic, rubber, cosmetic, chemical, refractory, fertilizers and gypsum products industries.

Although the reported consumption of talc for 1988 is 70 584 t, the true consumption for that year was probably closer to 90 000 t. Previous years' experience has shown that consumption reported to EMR represents approximately 80% of the total consumption.

Shipments

In 1989, reported Canadian shipments of talc, steatite and pyrophyllite remained almost unchanged from 1988 at around 146 000 t. However, the average unit value for the products decreased by approximately $4 to $105/t. To protect the producers' confidentiality, the average unit value was calculated from the values of all three mineral products (talc, steatite and pyrophyllite). Since these values vary considerably from each other, the reader should consider that changes in the average unit value from year to year may reflect variations in shipments of individual products and are not always indicative of a change in the unit value of talc, which is by far the most important and valuable mineral product examined in the present review.

Currently, talc is produced in the provinces of Ontario and Quebec and pyrophyllite in the province of Newfoundland. Preliminary figures for 1989 showed, as indicated above, a slight decrease in total shipments of talc, steatite and pyrophyllite from 1988. This almost unchanged performance over last year is observed in all three mineral products. Indeed, detailed tonnage figures provided to EMR for 1989, on a confidential basis, showed little variation from 1988.

According to the 1988 global production figures, Canada is now, with Italy, the twelfth (12th) leading talc, steatite and pyrophyllite producer in the world. When last reviewed in 1987, Canada ranked fourteenth (14th), after Norway, for these commodities.

Trade

Imports of talc, steatite and pyrophyllite for the first nine months of 1989 were 36 518 t, 145 t and 691 t respectively. When compared to the same period in 1988, total imports of crushed or powdered talc increased by 16.7% to 33 769 t while, on a value basis, a slight increase of steatite and pyrophyllite imports was observed. The substantial increase in imports of talc can be accounted for by a greater penetration of the Canadian market by U.S. producers such as Montana Talc Co. and Vermont Talc, a division of Omya, Inc., which were serving western Canada and part of central Canada with extremely competitive prices. This severe competition from the United States was evidenced by the fact that the unit value for crushed and powdered talc imports decreased on average by 15% to $188/t from 1988 to 1989. All of the pyrophyllite and almost all of the talc came from the United States during the first nine months of 1989. However, for that same period, the United States was responsible for only 60% of the crude steatite imports; the remaining 40% came from Brazil, China and Sweden.

Exports of crushed or powdered talc for the first nine months of 1989 were 29 896 t. This represents a decrease of 7520 t or 20% from the same period in 1988. Talc as well as steatite and pyrophyllite are exported almost exclusively to the United States. Lower exports were again a reflection of the very stiff competition from U.S. producers. It was particularly true for the product sold as a pitch-control agent in the pulp industry, a product that is quite important for the Canadian talc producers. High freight costs and a strong Canadian dollar were other factors which have contributed to these lower sales in the United States.

Deposits

Two of the four original Canadian talc producers have been progressively acquired by Talcs de Luzenac SA of France during the last four years. On October 1st, 1989, Luzcan Inc. (originally B.S.Q. Talc Inc.) and Luzenac Inc. (originally Steetley Talc Inc.) merged to form one company. This company, now with mining properties in Ontario and Quebec, will operate under the name of Luzenac Inc. The Ontario property is an open-pit operation located in Penhorwood Township, 70 km southwest of Timmins. At that locality, talc occurs in talc-magnesite deposits derived from the alteration of ultramafic volcanic rocks. Ore is processed by flotation and is fine-ground to high-purity platy products such as fillers for the paint, paper, plastic and rubber industries. Grades for the cosmetic and pulp industries are also produced. A program to study the possibility of increasing production capacity, producing magnesite and using new technology for continuous extraction at the mine was completed in 1987. In the years that followed, the increase in capacity was implemented, but the other two ideas were not pursued. Current capacity is 55 000-65 000 t/y, depending on product mix. The Quebec property, also an open-pit operation, is located near St-Pierre-de-Broughton. At that locality, Luzenac Inc. mines two deposits from the Pennington dike in the Leeds and Thetford townships. There, talc occurs in ultramafic intrusives, peridotite-serpentinite, and in quartz-carbonate-chlorite schists. Luzenac Inc. produces from the schist zone a ground carbonate-talc product that contains nearly 70% talc. This material is used as a filler in joint cement, auto-body compounds and plastics, and as a dusting agent in asphalt roofing shingles and rubber products. Benefiting from the parent company's expertise, the Quebec plant is also involved in talc-carbonate and talc-chlorite products suitable for paint, flooring and plastics end-uses. The Quebec operation is involved, on a small scale, in the production of steatite refractory slabs and sculpture blocks. Current plant capacity is about 40 000 t/y but it can easily be expanded to 60 000 t/y should market demand so permit.

Bakertalc Inc. produces talc and steatite from an underground operation at South Bolton, Quebec, 95 km southeast of Montreal. Talc, associated with serpentine and magnesite, occurs as dikes and sills in Cambrian and lower Ordovician schists. The ore is extracted from the Van Reet mine and trucked 16 km south to the company's processing plant at Highwater where a high-quality talc grade is produced for use in the pulp and paper industry as well as dry-milled talc grades for use as industrial fillers in paints and plastics. Bakertalc Inc. is also a supplier of steatite slabs and blocks. St-Lawrence Chemical Inc. is the sole distributor of Bakertalc's products. In 1987, the company completed an expansion program which doubled its production capacity of high-purity talc for paper and plastic applications. The installation of its new pebble mill increased the company's overall production capacity to approximately 18 000 t/y.

Canada Talc Limited operates both underground and open-pit talc orebodies at Madoc, Ontario. The orebodies occur in crystalline dolomite where tabular hydrothermal replacement was the principal alteration mechanism. At that locality, talc is of exceptional whiteness. Mineral impurities consist mainly of sulphides, mica and prismatic tremolite. The company produces both talc and dolomite from its orebodies. Present production capacity for talc is in the order of 30 000 t/y. In 1990, Canada Talc Limited will have access to a micronizer mill which will allow the company to produce finer ground talc products. Its new products will be sold mainly to the pulp and paper and plastic industries.

Pacific Talc Ltd. owns a talc deposit located 17 km north of North Bend in southwestern British Columbia. The deposit has an exposed strike length of 500 m and a width varying from 10 to 50 m. Diamond drilling has proven reserves of 1 Mt grading 60% talc. The mineral association consists of an admixture of talc (60%) and magnesite (30%) with minor quantities of chlorite (3-8%), carbonate (0.5-2%) and iron oxide (6%). Laboratory studies have shown that the talc can be readily liberated and concentrated by flotation, and pilot plant testing proved that a high-quality paper-grade talc could be produced into wettable talc products in high solids slurry form. Pacific Talc Ltd. is now entering Phase III of its project which involves engineering and development stages to build a processing plant.

Trifco Minerals Ltd. possesses interest in a talc deposit located 35 km east of Quesnel, British Columbia. Geological investigations that followed a 1986 drilling campaign enabled the company to estimate the reserves at 600 000 to 700 000 t grading 60% talc. The talc is associated with ultramafic rocks, but a recent petrographic study identified concentrations of dolomitic and magnesitic talc.

Carey Canada Inc. announced in 1987 the discovery of a large, high-grade talc deposit located on farmland between the towns of Leeds Station and East Broughton, Quebec. Preliminary diamond drilling results at that time indicated that the deposit possibly contains 8 Mt of ore grading 78 to 80% talc. About one half of that tonnage would require no stripping, while the remaining 4 Mt would require limited stripping. Laboratory and pilot plant testing through flotation cells and a micronizer that pulverizes the ore to -2 microns indicated recoveries of 85 to 90%, while metallurgical testing showed no associated asbestos or tremolite and revealed the presence of calcite and dolomite in quantities of less than one percent. In the early spring of 1990, further diamond drilling will be carried out to precisely determine the morphology of the deposit and to estimate the ore reserves.

Commercial Industrial Minerals Limited (CIML) holds mining leases on a large talc/clarendite deposit near Robertsville, Ontario. In the later part of the 1980s, the company made modifications to its milling facilities in Clarendon for the production of a wide variety of industrial minerals. However, CIML's current primary product is clarendite. Ore reserves have been estimated at 2 Mt of clarendite and 0.35 Mt of talc.

Armstrong World Industries Canada Ltd. (Newfoundland Minerals Division) mines pyrophyllite from an open-pit operation near Manuels, 19 km southwest of St. John's, Newfoundland. The deposit appears to be the result of a hydrothermal alteration of sheared rhyolite which is found in a zone of extensive fracturing near granite contacts. Reserves are believed to be sufficient for 40 years at current production levels. The ore is crushed, sized and hand-cobbed at the mine site. Production capacity is estimated at about 65 000 t/y. The high-quality crude ore (a pyrophyllite-quartz product with minor sericite) is shipped to the United States where it is finely ground for use in ceramic tiles. Small quantities of some lower-grade pyrophyllite is also used in the local manufacture of joint cement, paint and other products.

WORLD OVERVIEW AND DEVELOPMENTS

In 1988, world production of talc and pyrophyllite remained almost unchanged from 1987 at around 7.5 Mt. Talc accounted for approximately 78% of that production, the remaining 22% being mainly pyrophyllite and small amounts of steatite and chlorite. Asia is responsible for about 43% of the world production (3.2 Mt) of talc and pyrophyllite. However, Asian production includes the majority of the world pyrophyllite production of 1.7 Mt, with Japan alone producing in excess of 1 Mt of pyrophyllite each year. North America occupies the second place with 19% of the world production of talc and pyrophyllite, followed by Western Europe, 14%; the U.S.S.R., 8%; and South America, 5%. The four leading producer countries of talc in the western world are the United States with 1.15 Mt and India, Brazil and

Finland, each with around 0.4 Mt/y. As mentioned above, Japan is by far the most important producer country of pyrophyllite with more than 1.0 Mt/y. Other important producer countries are the Republic of Korea (South Korea) with 0.5 Mt and the United States with a production of approximately 100 000 t/y. Canada also produces pyrophyllite. Its production varies between 40 000 and 50 000 t/y.

United States

According to the U.S. Bureau of Mines, the United States' crude talc mine production increased by 7% in tonnage and 1% in value from 1987 to 1988. Mining occurred in ten states, but operations in Montana, New York, Texas and Vermont were responsible for 92% of U.S. production.

In 1988, Cyprus Industrial Minerals Company acquired Vermont Talc and Windsor Minerals Inc., both companies being major talc producers in Vermont. The acquisition of Vermont Talc added a mine in Windham, a mine near Troy, a plant in Chester and a flotation mill in Johnson, while that of Windsor Minerals gave Cyprus several mines and two mills.

The U.S. Bureau of Mines estimated that consumption of crude and processed talc and pyrophyllite in the United States has increased by 3% from 1987 to 1988. The ceramic industry accounted for 34% of the consumption followed by paint (14%), paper (13%), roofing (11%), plastics (10%), and cosmetics (5%). The remaining 13% went into the production of insecticides and refractories and was used by the rubber and other industries.

According to the U.S. Bureau of Mines, pyrophyllite was extracted from six mines located in California and North Carolina and production, which involved four companies, increased by 16% from 1987 to 1988. Pyrophyllite was used mainly for ceramics (55%), refractories (14%) and insecticides (7%). The remaining 24% was consumed by the paint, plastics, roofing, rubber and other industries.

China

Ilshin Industrial of South Korea and Cyprus of the United States were planning a tripartite joint venture with a Chinese mining firm to develop talc sources in China. According to reports, Ilshin and Cyprus will install mining facilities, while the Chinese will provide a talc mine. It is expected that a total of 40 000 to 50 000 t of talc ore will be mined annually. The partners have indicated that a plant will initially be built near the mine to process 20 000 t of talc ore into fine talc powder for export to Korea and elsewhere. Korea has been importing 60 000 to 70 000 t/y of talc ore from China to meet the growing demand for talcum powder.

France

Talc production in Europe is dominated by the French company Talcs de Luzenac SA and its subsidiaries. In France, Talcs de Luzenac SA is the only producer of the mineral with an open-pit operation at Trimouns on the northern slopes of the Pyrenees near Ax-les-Thermes. The company has interests in Italy, Austria, United States and now Canada as a result of its recent acquisitions of B.S.Q. Talc Inc. and Steetley Talc Inc.

Trimouns is Luzenac's most important operation. From that locality, 325 000 t of talc was produced in 1987, a tonnage which represented about 60% of the company's total annual production.

Brazil

Inpacel, a wood-pulp maker based in Arapoti, Parana State, and controlled by the Bamerindus banking group, plans to form an association with Itaiacoca Mineracao S.A. to produce high-grade talc for use by the paper industry. The special talc venture is Brazil's first move to substitute the kaolin, traditionally used to whiten paper. The new plant is expected to come on-stream at the end of 1990, along with an additional writing and printing paper unit. The company stated that excess talc not used by the paper unit will be sold on the domestic market.

Spain

Cyprus Industrial Minerals Company has completed the acquisition of Distribuidora Malaguena de Talcos S.A. (DIMTASA). According to the U.S. Bureau of Mines, Cyprus' intention is to produce high-value talc for the paint, paper and plastics industries. Crude talc will originate from Australia and the United States.

USES AND SPECIFICATIONS

Talc is an extremely versatile mineral which is used primarily in a fine-ground state. Steatite is essentially used in massive or block form. There are many industrial applications of ground talc, although fewer than a dozen countries use talc on a major scale.

In pulp and paper, softness, chemical inertness, high reflectance, hydrophobic and organophilic properties and the particle shape of talc are characteristics that permit its use as a pitch-control agent, as a paper filler and as a coating pigment. For filler applications, generally maximum particle size should not exceed 20 microns, although 40 micron grades are also used for some applications. As a coater, talc particle size must not exceed 10 microns and as a pitch-control agent, it should be as close to one micron as possible.

In ceramics, finely ground talc is used to increase the translucence and toughness of the finished product and to aid in promoting crack-free glazing. Talc must be low in iron, manganese and other impurities which would discolour the fired product. Average particle size for talc used for most ceramics must range between 6 and 14 microns, with 90-98% of material passing through 45 microns mesh screen.

In plastics, talc improves dimensional stability, chemical and heat resistance, impact and tensile strength, and electrical and insulation properties. Talc is used in both thermoplastics and thermosets, primarily in polypropylene, nylon and polyester. Chemical coupling agents are used to enhance the bond between the talc filler and the resin matrix in plastic materials. The mineral must be free of iron impurities and grits, and the average particle size must be less than eight microns.

In paints, high-quality talc is used as a pigment extender. A low carbonate content, a near white colour, a fine particle size with controlled size distribution and a specific oil absorption are required properties. However, due to the large variety of paints, precise specifications for talc pigments are often agreed upon between consumers and suppliers. Paint characteristics which influence the use of talc as a pigment extender are gloss, adhesion, flow, hardness and hiding power.

In pharmacy, high-purity talc is used in preparations and cosmetics mainly because of its softness, its hydrophobic property and its chemical inertness. When finely ground, high-purity talc can be used as a filler in tablets and as an additive in medical pastes, creams and soaps.

In construction, lower-grade talc is used as a dusting agent for asphalt roofing and rubber products, as a filler in drywall sealing compounds, floor tiles, asphalt pipeline enamels, auto-body patching compounds, and as a carrier for insecticides. Other applications include cleaning compounds, polishes, electric cable coatings, foundry facings, adhesives and linoleum backings.

Steatite that can be cut, sawn and easily carved is mainly used in sculpturing. However, the material can also be used as refractory bricks or blocks and, because of its softness and resistance to heat, as marking crayons for metal workers.

Pyrophyllite can be ground and used in much the same way as talc. In ceramics, it imparts a very low coefficient of thermal expansion to tiles. For that application, the product must be ground to minus 45 microns and must contain minimal amounts of quartz and sericite impurities. Because of its much lower heating shrinkage than fireclays and its ability to maintain its strength after heating, pyrophyllite is also used by the refractory industry. Foliated or micaceous varieties are utilized as fillers.

PRICES

Canadian prices for most grades of talc remained unchanged in the last three years. However, the price of talc used as a pitch-control agent in the pulp industry, the most common grade produced in Canada, has dropped by 25% from about \$200/t in 1987 to \$150/t in 1989. Severe competition from the United States, particularly from Montana Talc Co., and Cyprus Minerals Company, and a North American capacity/demand imbalance are mainly responsible for the lower price. Current demand in North America is estimated at 1.2 Mt while production capacity is at the level of 1.5 to 1.8 Mt.

List prices for ceramic and filler grade pyrophyllite ranged between \$30 to \$45/t for bulk material, f.o.b. plant. In 1989, the average price for a metric tonne of pyrophyllite was \$7 lower than that of 1988 and was closer to the lower end of the above price range.

OUTLOOK - OPPORTUNITY

Canadian producers expect that talc used in plastics will experience the fastest growth in the coming years in North America. They expect a 5% growth in that sector. Some producers are of the opinion that surface-treated talc for plastics, a product characterized by a high profit margin, represents a potential avenue for product diversification.

Environmental pressures to recycle waste papers may contribute to a greater demand for talc by the pulp and paper industry. EMR's recent survey of minerals used by the Canadian pulp, paper and paperboard industry enabled us to predict a future growth of 4% for that industry, a growth which corresponds to a consumption of 42 000 t by the year 2000.

Western Europeans use three times more talc, as a paper-making pigment to enhance the quality of paper, than North Americans. That particular application, perhaps, represents an opportunity for the Canadian industry. Currently, talc supplied to the pulp and paper industry by Canadian producers is used mainly as a pitch-control agent.

Note: Information contained in this review was current as of mid-January 1990.

PRICES

Talc: F.o.b. mine, bagged, carload lots

	US$/short ton
New York	
Ground	84.00
99.5%, 325 mesh	84.00 - 90.00
99.5%, 400 mesh, micronized	187.00 - 238.00
99.5%, 625 mesh, micronized	200.00
Vermont	
Ground, off-colour	136.00
California	
Ground	90.00
Talc	
Norwegian, ground (ex-store) United Kingdom	£95-105
Norwegian, micronized (ex-store) United Kingdom	£125-175
French, fine ground c.i.f.	£120-190
Italian, cosmetic c.i.f.	£175
Chinese, normal, ex-store United Kingdom, 200 mesh	£144
Chinese, normal, ex-store United Kingdom, 325 mesh	£150
New York, paint, min. 20 ton lot	£165
Pyrophyllite	
Australian, bulk, ex-store	
Refractory grade	25-35
Ceramic and filler grades	35-45
United States, min. 20 ton lot. for export, f.o.b.	80-82

Sources: Chemical Marketing Reporter, November 10, 1989 and Industrial Minerals, January 1990.
c.i.f. Cost, insurance and freight; f.o.b. Free on board.

TARIFFS

Item No.	Description	Canada			United States
		MFN	GPT	USA	Canada
2526	Natural steatite, whether or not roughly trimmed or merely cut, by sawing or otherwise, into blocks or slabs of a rectangular (including square) shape; talc				
2526.10.00	- Not crushed, not powdered	9.2%	6%	7.3%	0.032¢/kg
	On and after January 1, 1990			5.5%	0.024¢/kg
	On and after January 1, 1991			3.6%	0.016¢/kg
2626.10.00.10	-----Natural steatite				
2526.10.00.20	-----Talc				
2526.20	- Crushed or powdered				
2526.20.10.00	--- Talc of a particle size not exceeding 20 microns	4%	Free	3.2%	1.9%
	On and after January 1, 1990			5.5%	1.4%
	On and after January 1, 1991			1.6%	0.9%
2526.20.90.00	--- Other	9.2%	6%	7.3%	1.9%
	On and after January 1, 1990			5.5%	1.4%
	On and after January 1, 1991			3.6%	0.9%
2530.90.40	Pyrophyllite	Free	Free	Free	Free

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989.

TABLE 1. CANADA, TALC, STEATITE AND PYROPHYLLITE SHIPMENTS, TRADE 1988 AND 1989 AND CONSUMPTION 1986–88

		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Total shipments (talc, steatite and pyrophyllite)		146 489	16 023	146 000	15 400
Imports				(Jan.-Sept.)	
2526.10.00.10	Natural steatite, not crushed, not powdered				
	United States	280	112	88	65
	Other countries (Brazil, China and Sweden)	49	12	57	41
	Total	329	124	145	106
2526.10.00.20	Talc, not crushed, not powdered				
	United States	2 695	525	2 714	289
	Other countries (China and France)	40	23	35	19
	Total	2 735	548	2 749	308
2526.20.10.00	Talc of a particle size not exceeding 20 microns, crushed or powdered				
	United States	17 631	4 149	17 127	3 445
	Other countries (Japan, United Kingdom and U.S.S.R.)	65	6	7	4
	Total	17 696	4 155	17 134	3 449
2526.20.90.00	Other natural talc, crushed or powdered				
	United States	17 869	3 634	16 631	2 892
	Other countries (United Kingdom, Netherlands)	200	27	4	2
	Total	18 069	3 661	16 635	2 894
2530.90.40.00	Pyrophyllite				
	United States	811	64	691	46
	Total	811	64	691	46
Exports					
2526.10.00	Natural talc, not crushed, not powdered				
	United States	2 082	602	746	212
	Total	2 082	602	746	212
2526.20.00	Natural talc, crushed or powdered				
	United States	42 419	7 823	29 125	5 341
	West Germany	919	306	527	190
	United Kingdom	292	218	224	77
	Other countries	192	131	20	7
	Total	43 822	8 478	29 896	5 615

TABLE 1. (cont'd)

	1986	1987	1988[p]
		(tonnes)	
Reported Consumption[1] (ground talc, available data)			
Pulp and paper and paper products	23 731	24 249	28 689
Asphalt roofing products	20 181	20 839	21 410
Paint and varnish	6 481	5 547	6 708
Ceramic products	3 658	3 000	4 155
Rubber products	1 629	2 097	2 786
Toilet preparations	1 496	1 438	1 398
Other products[2]	8 058	8 783	5 438
Total	65 234	65 953	70 584

Sources: Statistics Canada; Energy, Mines and Resources Canada.

[1] Reported from EMR survey on the consumption of nonmetallic minerals by Canadian manufacturing plants.

[2] Chemicals, fertilizers, gypsum products, refractory brick and other miscellaneous uses.

[p] Preliminary.

TABLE 2A. CANADA, TALC, STEATITE AND PYROPHYLLITE SHIPMENTS, 1970, 1975 AND 1980–89

	Tonnes
1970	65 367
1975	66 029
1980	91 848
1981	82 715
1982	70 523
1983	97 030
1984	122 992
1985	126 860
1986	123 037
1987	136 418
1988	146 489
1989[p]	146 000

Source: Energy, Mines and Resources Canada.

[p] Preliminary.

TABLE 2B. CANADA, TALC IMPORTS AND EXPORTS, 1982–88

	Imports	Exports to United States
	(tonnes)	
1982	33 895	9 550
1983	34 808	16 345
1984	38 117	22 512
1985	40 466	26 912
1986	38 745	33 997
1987	48 595	35 232
1988	38 500	42 472

Sources: Statistics Canada for Imports, and U.S. Bureau of Mines, Minerals Yearbook for Exports.

TABLE 3. WORLD PRODUCTION OF TALC, STEATITE AND PYROPHYLLITE, 1984–88

	1984	1985	1986	1987[p]	1988[e]
			(000 t)		
Japan[1,2,3]	1 499	1 434	1 334	1 300	1 268
United States[1,3]	1 023	1 151	1 184	1 165	1 252
People's Republic of China	875[e]	875[re]	875[e]	900[e]	900
Republic of Korea[1,3]	849	932	800[r]	854	853
U.S.S.R.[e]	517	517	517	527	527
India[2,3]	418	383	396[r]	412	411
Brazil[1,3]	413	387[r]	380[r]	400	400
Finland	327	318	284	324	379
France (ground talc)	292	311	315[r]	330	331
Australia[1,2,3,4]	187[r]	140[r]	188[r]	189	190
North Korea[e]	168	168	168	168	168
Italy[1,2]	143	130	151	152	155
Canada[1,2,3]	123	127	123	136[r]	146[r]
Norway	112[re]	100[e]	100[e]	100[e]	50[re]
Austria (unground talc)	134	131	134	130	130
Other countries	399	433	422	396	380
Total America	7 479	7 537	7 371	7 483	7 540

Sources: U.S. Bureau of Mines, Talc and Pyrophyllite 1988; Energy, Mines and Resources Canada.
[1] Talc; [2] Steatite; [3] Pyrophyllite; [4] Chlorite.
[p] Preliminary; [r] Revised; [e] Estimated; [re] Reported.

TABLE 4. NORTH AMERICAN PRODUCERS OF TALC, STEATITE AND PYROPHYLLITE

Company	Parent Corporation	Production Capacity	Remarks
Luzenac Inc.	Talcs de Luzenac SA	95-105 000	full line of products
Bakertalc Inc.		18 000	paper, joint compounds, paint
Canada Talc Limited	William R. Barnes Co.	30 000	paint, adhesives, plastics, ceramics
Armstrong World Industries Canada Ltd.	American Olean Tile Co.	65 000	ceramics (pyrophyllite)
Gouverneur Talc Co. Inc	R.T. Vanderbilt Co. Inc.	230 000	ceramics, paint and paper
Windsor Minerals, Inc.	Cyprus Minerals Company	225 000	joint compounds, rubber, asphalt roofing, plastics
Vermont Soapstone Co. Ltd.		. .	
Vermont Talc	Cyprus Minerals Company	100 000	full line of products, excluding ceramics
Blue Ridge Talc Co. Inc.		. .	
Glendon Pyrophyllite Co.		200 000	joint compounds, refractories
Piedmont Minerals Co. Inc.	Resco Products Inc.	85 000	porcelain, refractories, plastics
Standard Mineral Co. Inc.	R.T. Vanderbilt Co. Inc.	50 000	ceramics, paint
Southern Talc Co.	United Catalysts Inc.	20 000	asphalt coating, insecticide
Cyprus Industrial Minerals Company	Cyprus Minerals Company	. .	fed by Montana mines
The Milwhite Co., Inc.		. .	
Southern Clay Products Inc.	ECC America Inc.	30 000	wall tile, off-white filler
Westex Minerals Co.	The Milwhite Co., Inc.	90 000	ceramics
Pioneer Talc Co.	Whittaker, Clark & Daniels	50 000	wall tile, off-white filler
Apache Minerals Inc.		. .	
Texas Talc Inc.	Dal-Til	25 000	wall tile
Cyprus Industrial Minerals Company	Cyprus Minerals Company	25 000	ceramics
Pfizer Inc.		90 000	ceramics
Standard Industrial Minerals Inc.	Standard Slag Co.	1 000	pharmaceuticals and cosmetics
Standard Slag Co.		. .	
Huntington Tile, Inc.		. .	
Steatite of Southern Oregon		500	steatite blocks
Cyprus Industrial Minerals Company	Cyprus Minerals Company	125 000	full line of products
Pfizer Inc.		135 000	full line of products
Montana Talc Co.	Westmont Mining	36 000	pulp and paper
U.S. American French Talc Inc.	Talcs de Luzenac SA	15 000	fed from European mines

. . Not available.

Tin

1989

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Tin prices, expressed in U.S. dollars, increased from $3.25 in 1988 to an average of $3.92/lb. in 1989. The higher average price, however, masked sharp price escalation in the first half of the year and an even stronger fall during the second half. Mine production increased significantly with new low-cost production from independent Brazilian tin prospectors, the garimpeiros. Tin mine production also increased in Indonesia, Bolivia and Malaysia. Metal consumption increased very little during 1989. An out-of-court settlement was reached on the collapse of the International Tin Council (ITC). The Association of Tin Producing Countries (ATPC) in March renewed its so-called tin rationalization scheme for another year by allocating significant increases in allowable export levels for its members and non-members.

CANADIAN DEVELOPMENTS

Canadian tin mine production is from the 21 000 t/d open-pit mine located in East Kemptville, Nova Scotia. Early in 1988, Rio Algom Limited bought back the mine it had originally developed and opened in 1985. In 1986, Rio Algom wrote off its investment because of the collapse of tin prices, and ownership reverted to the creditor banks which maintained operation under Rio Algom management.

The East Kemptville ore is complex and concentration by gravity and magnetic methods has not been an easy task. In the last two years, Rio Algom worked to improve its tin recovery rate to the mid-70% range by making improvements to the grinding, dewatering and gravity equipment and by installing a new flotation circuit. The tin recovery rate was in the 30% range when the mine first opened. Rio Algom is also seeking to improve recovery of copper and zinc and planned the construction of column flotation cells.

The mine contains an orebody originally estimated at 56 Mt grading 0.163% tin plus small quantities of copper and zinc. Its remaining reserves are estimated at 36 Mt which is equivalent to about 11 years of production at the current production rate. Rio Algom has a diamond drilling program which is concentrated on the south end of its site.

Adjacent to the Rio Algom mine, Guinness Gold Resources Ltd. began a drilling program on the property recently acquired from Acadia Mineral Ventures Limited.

LAC Minerals Ltd. and Billiton Metals Canada Inc. completed a feasibility study in 1988 at Mount Pleasant in New Brunswick and concluded that the estimated 5.1 Mt deposit grading 0.79% tin was uneconomic at a tin price of US$3.50. In 1989, NovaGold Resources Incorporated reached an agreement with LAC Minerals and Billiton to reassess the potential of the Mount Pleasant property by applying new tin recovery and smelting technologies. Billiton spent about $120 million in the early 1980s to bring the mine into production as a tungsten operation. The mine was closed in 1985 due to depressed tungsten prices and difficulties in treating the complex ore.

As a by-product of the production of indium, Cominco Ltd. produces a small quantity of tin-lead alloy at its smelter in Trail. The alloy is used for solder applications.

Since Rio Algom exports its tin products in concentrates, Canada relies on imports for its tin metal requirements except for small amounts recovered from recycled solders, detinning and Cominco's tin-lead alloy production. Consumption has been remarkably stable since 1984. Refined tin is imported by two large Canadian steel-makers, Stelco Inc. and Dofasco Inc., for producing tin plate for use primarily in can production.

WORLD DEVELOPMENTS

Brazil

An important development in tin was the emergence of Brazil as the world's largest tin producer. The National Department of Mineral Production reported an estimated tin production of 50 161 t in 1989, up from 44 102 t in 1988.

Brazil's share of the western world concentrates production increased from 16.9% in 1985 to 28.3% in 1988 and its share increased slightly more in 1989. In addition, it is also estimated that as much as 5000 t of tin was smuggled abroad in 1989 through the amazonian jungle.

Tin production comes from two main areas, the State of Rondonia which produced 29 545 t in 1989, up from 19 713 t in 1988, and from the Pitinga mine in the State of Amazonas, with production of 17 888 t and 19 500 t, respectively, in 1989 and 1988.

The discovery of large cassiterite reserves almost on the surface in the remote State of Rondonia in Brazil has created the equivalent of a "gold rush" for tin since September 1987. Within months, some 18 000 persons became tin prospectors-extractors, the so-called garimpeiros. The garimpeiros have formed cooperative entities which then sell to tin companies. Under Brazilian law, individual mining operations are illegal but cooperatives are not. The bulk of the cassiterite tin concentrates is trucked to Sao Paulo State, 3500 km away. Despite the distance, smelters can produce tin metal economically.

Brazil is not a member of the ATPC but has agreed to cooperate in limiting its exports to a level determined in consultation with the ATPC. The agreement with the ATPC is implemented by Cacex, the foreign trade department of the Banco do Brasil, which allocates allowable exports to companies. Brazil successfully negotiated a 20% increase in its export quota for the 12 months beginning March 1989. Furthermore, it received authorization to release an additional 2750 t from stocks in April as part of the ATPC's special effort to ease upward pressures on prices. Overall, in the context of the so-called restraint by the ATPC members, Brazil was able to export 34 250 t in 1989, up from 21 000 t in 1987, plus an undetermined tonnage of smuggled tin.

Malaysia

In June 1989, there were 253 mines in active operation, up from 219 a year earlier. With this new capacity, Malaysian authority anticipated in mid-year that 1989 production would reach 31 676 t, up from 28 866 t in 1988. Because of the price decline in the second half of 1989, final figures are likely to be slightly below the anticipated figure. Production in 1990 is also expected to fall back to the 1988 level. In the 1960s and 1970s, there were more than 1000 mines in operation. Malaysia's share of western world concentrates production declined from 40% in 1970 to 23.3% in 1985 and to 18.5% in 1988.

Bolivia

Bolivia's share of western world concentrates production declined from 10.2% in 1985 to 6.3% in 1988 due to the closure of high-cost mines. In 1989, tin output is expected to jump by about 40% due to the re-opening of eight mines in the last two years by Corporacion Minera de Bolivia (Comibol), a state-owned company. The mines re-opened include: the large Huanuni mine in 1988, the Bolivar mine in Oruru in 1988, which is now doubling its capacity, and the Colquiri tin-zinc mine in mid-1989.

Indonesia

Indonesia is the only member country of the ATPC whose tin production has increased since 1985 and is also the only one able to meet its export quota. Indonesia's share of western world concentrates production increased from 13.7% in 1985 to 19% in 1988. In 1989, additional investments were made and production was expected to reach 31 500 t, up from 29 589 t in 1988. It is also claimed by the Indonesian Mines and Energy Ministry that with new investments, mine output could be raised to 37 000 t/y in the near future. The state-owned P.T. Tambang Timah company accounts for about 80% of Indonesian production. Tin smuggling is also reported to occur from farmers who illegally mine tin.

THE ASSOCIATION OF TIN PRODUCING COUNTRIES

The ATPC began a supply rationalization scheme in March 1987 with the objective of accelerating the absorption of the huge tin stock overhang caused by the cessation of the buffer stock operations of the International Tin Council, and to prevent further price declines. The scheme involved the establishment of an overall export quota of 96 000 t for the 12 months beginning in March 1987 divided among its seven members, i.e. Malaysia, Indonesia, Thailand, Bolivia, Australia, Zaire and Nigeria. Brazil and China, although non-members, also cooperated in limiting their exports initially to 21 000 t and 7000 t, respectively.

In March 1988, it was estimated by ATPC that the stock overhang had been reduced from 73 000 t to 47 000 t. The export restrictions were renewed for another 12-month period ending in March 1989 at a level of 101 900 t for ATPC members, 26 500 t for Brazil and 10 000 t for China. Over the period, the rate of depletion of the stocks slowed considerably, to an estimated 44 000 t at the end of 1988.

The export restrictions were again renewed in March 1989 at another increased level of 106 500 t for ATPC members, 31 500 t for Brazil and 10 000 t for China. In April, due to strong price recovery, the ATPC decided to release an additional 8000 t from stocks held by producers to ease the price escalation. Indonesia, Malaysia and Thailand were allocated 2500 t, 2000 t and 560 t respectively, and Brazil was allocated 2750 t. The gesture reflected a desire by producers to limit the price increases in order to avoid losing the recently hard-gained increases in consumption and to discourage new mine capacity coming into operation.

By year-end, as a result of the sharp decline in price from about US$4.60 to $3.00/lb. since May, ATPC members considered whether to effectively reduce 1990 export levels relative to 1989 levels. It is indeed the first time that ATPC members considered a nominal decline in export levels. In such a context, agreement among ATPC members on individual quotas is likely to be tenuous in 1990 and even more so with Brazil and China.

The ATPC argues that its rationalization scheme is the primary factor in the reduction of the stock overhang in 1987-88. However, this allegation is not supported by the evidence. Indeed, the price collapse in 1985-86 apparently played a more significant role in reducing mine output in countries with high operating costs, i.e. Bolivia, Malaysia and the United Kingdom. Similarly, under the so-called export restriction program, export levels were increased every year and most ATPC members have difficulty in meeting their increased export quotas. For example, Malaysian mine output declined by 2000 t in 1988 and dropped by about 30% between 1983 and 1988. In 1988, Bolivia was criticized by other ATPC members for having permitted Brazil to use 2000 t of its unused quota. Thailand mine production has declined every year since 1985.

OTHER TIN PRODUCERS

Portugal

The Neves Corvo open-pit copper mine was opened in December 1988. The large copper deposit also includes an estimated 2.8 Mt of tin ore grading 2.6%, which is likely to yield 5000 t/y of tin in concentrates in 1990 and up to 10 000 t/y when copper production reaches full capacity. As a by-product of copper, tin will be recovered at low cost. The mine was developed by Sociedad Minera de Neves-Corvo (Somincor), owned 51% by the state-run Empresa de Desenvolvimento Mineiro EP and 49% by RTZ Corporation PLC. Somincor invested $60 million in a tin concentrator. This new source of tin, insensitive to prevailing tin prices, is likely to delay the re-opening of higher cost tin operations that were closed following the price collapse in 1985.

China

Information on China's tin industry is sparse and there are uncertainties as to whether tin exports achieved in recent years can be sustained in the future. On the one hand, domestic demand for nonferrous metals and steel has been strong, and frustration of the domestic manufacturing sectors with inadequate metal supplies led to the imposition in 1988 of export restrictions on scarce materials, including copper and its alloys, aluminum and its alloys, nickel and its alloys, nickel products, platinum and yellow phosphorus. On the other hand, China needs foreign currencies to sustain its expanding import requirements and to offset its losses of foreign exchange on banned exports.

For the period 1989-90, China agreed to abide with an unchanged 10 000 t export limit under the ATPC rationalization scheme. However, some ATPC members believed that China exported some 18 000 t in 1989, which is denied by Chinese authorities. Chinese tin mine production in 1988 is estimated at about 40 000 t.

United States

The operational management of the national defense stockpile was shifted in 1988 from the General Services Administration (GSA) to the Defense Logistics Agency (DLA), an arm of the Pentagon. The U.S. President's executive order delegates to the Pentagon most of the functions authorized under the Strategic and Critical Materials Stockpiling Act. In 1989, the U.S. Defense National Stockpile Center (USDNSC) disposed of 2075 t of tin, much less than its 5000 t Congressional authority. In October, USDNSC received Congressional authority to release up to 7000 t in 1990. The goal for the stockpile is 42 674 t, compared with holdings of about 170 000 t in late 1989. Traditionally, the ATPC, as part of its rationalization scheme, has urged the United States to restrict releases of tin from its strategic stockpile to avoid disturbing the market.

INTERNATIONAL ORGANIZATIONS

The Sixth International Tin Agreement

The Sixth International Tin Agreement (ITA) was an international producer/consumer arrangement aimed at stabilizing the price of tin mainly through the operation of a buffer stock and by selective use of export controls. The Sixth ITA entered provisionally into force on July 1, 1982, under the direction of the International Tin Council (ITC). On October 24, 1985, the ITC ceased buffer stock operations and defaulted on loans and contracts. ITC creditors took various legal actions against the ITC and its members in the United Kingdom and elsewhere. After protracted negotiations between ITC members and its creditors, an out-of-court settlement was finally agreed to late in 1989. The settlement provides for a £182.5 million settlement, or about one third of the loss claimed by the creditors, and is to take effect March 30, 1990 when payment is made.

International Tin Study Group

With the demise of the ITC, interest has been expressed by major producers and consumers in the establishment of a group which would perform statistical functions but would not have any market intervention power. Under the auspices of the United Nations Conference on Trade and Development (UNCTAD), a Tin Conference was convened in late November 1988 and again in March 1989 to negotiate the establishment of an intergovernmental producer/consumer forum for tin which would have as a primary objective the collection and the dissemination of tin statistics. The terms of reference of such a group were adopted and countries interested in joining the group were invited to notify their intention to join by the end of 1989. The group shall enter into force when countries representing at least 70% of world trade in tin have so notified. So far, Malaysia, Indonesia and Nigeria have completed the notification formalities.

Research Organizations

The International Tin Research Institute is entrusted with the task of maintaining and extending the use and effectiveness of tin in modern technology. It is financed by the governments of five of the major tin-producing countries: Indonesia, Malaysia, Nigeria, Thailand and Zaire. Its headquarters and laboratories are in Uxbridge, Middlesex, England.

The South East Asia Tin Research and Development (SEATRAD) Centre is a regional organization established by the governments of Indonesia, Malaysia and Thailand, with assistance from the Economic and Social Commission for Asia and the Pacific and other United Nations agencies. The purpose of the Centre is to promote, conduct and coordinate research and training in relation to the technical and economic aspects of exploration, mining, mineral processing and smelting of tin. The Centre's headquarters and laboratories are located in Ipoh, Malaysia. In addition to the work being conducted in the laboratory, field projects are maintained in various member countries in southeast Asia. The Centre is financed by equal contributions from member countries.

USES

Tinplate traditionally has been the largest use of tin. Tinplate use in the canning industry has been under severe competitive pressures from aluminum. Also, thinner tin coatings on food and beverage cans have reduced consumption of tin for tinplate. However, with the recent increase in aluminum prices and low and relatively stable tin prices, tinplate has improved its cost-competitive position. Tinplate competition also comes from non-tin-coated steels, tin-free steel (TFS) or electrolytic chromium-coated steel (ECCS). In the United States, aluminum has taken over the large metal beverage container market. Similarly, the increasing popularity of the microwave oven has food producers examining alternate packaging materials including plastics and cellulose.

Solder is another traditional use of tin. In the United States and in Japan it may soon surpass tinplate as the largest market for tin. Strong growth in the electronics industry has provided a new impetus for this tin use. Growth in tin solder is, however, limited by the trend towards the use of less solder per assembly. This trend is more evident in the increasing use of surface-mounted components which permits greater solder savings. A growing trend in North America, due to regulatory actions, is to replace standard lead-tin solder in water pipes with silver-tin solder. This would increase tin consumption in solder, since the latter is 95% tin versus about 50% in the former.

The fastest growing new use for tin has been in chemical applications. Tin is used in an array of inorganic and organic chemicals, for application as

P.V.C. stabilizers, agricultural pesticides, anti-fouling paints for ships and biocidal compounds for the protection of materials such as paints, textiles and building materials.

Tin is also used for tinning (which includes electronic uses, hot dipping and electroplating in the electronics industry), in the manufacture of pewterware, and in bronze, brass and other tin-containing alloys. Tin-containing alloys are used in construction, machinery and equipment and consumer durables.

Tin consumption grew very slightly in 1989 due to the health considerations related to lead solder for water pipes and the growing chemical applications for tin. Consumption is expected to remain relatively flat in 1990.

PRICES AND STOCKS

After an absence of more than three years, tin trading was re-introduced on the London Metal Exchange (LME) on June 1, 1989. The new contract was denominated in U.S. dollars and at a high-grade specification, minimum 99.85% purity. With only 1200 t of high-grade stocks in LME warehouses when trading resumed and unreliable statistics on supply/demand and stocks, speculative transactions kept tin prices at an artificially high level for most of the summer. Early in the fall, LME stocks rose quickly and more realistic views on world supply and demand kept pushing prices downward. The price decline accelerated in November, when prices reached a yearly low of US$2.93. At the end of the year, LME stocks had risen to 9020 t up from 5590 t in January.

In 1988, the average tin price on the European Free Market (EFM) was US$3.25. In 1989, the average tin price calculated on the basis of the first five months' quotation on the EFM and seven months on the LME was US$3.92.

In 1988, our estimation of the tin market situation was that the market had been in a deficit of 8000 t with year-end stocks evaluated at 44 000 t. Our evaluation was also that at the end of 1988, the market had reached an equilibrium given the stability of stocks in the last months of the year. In 1989, a number of factors led us to believe that the tin market reached a surplus situation for the year as a whole. First, mine production increased by about 15 000 t, or almost 10%. Second, tin consumption remained virtually stable during the year. Finally, the LME prices fell below prevailing prices in 1988. These factors suggest that tin stocks were in excess of 44 000 t at the end of 1989 which is far more than the 36 000 t year-end stock reported by the ATPC. The absence of reliable statistics on tin markets makes it difficult to be confident about the current level of tin stocks.

The Kuala Lumpur Commodity Exchange (KLCE) began trading tin futures contracts in October 1987. The KLCE attempted to fill the void left by suspension of trading on the LME when the ITC ran out of funds in October 1985. In 1988, trading on the KLCE was quiet, not so much because of technical reasons related to the high cost of using the market or doubts about the security of the clearing system or time differences between Malaysia and Europe, but primarily because of lack of interest in hedging. Tin prices remained virtually stable for two years in 1987 and 1988.

OUTLOOK

The average tin price in 1990 is expected to decline significantly relative to that in 1989, hovering within a range of US$2.60-3.20. The tin market was in surplus in 1989 and is heading to a larger surplus in 1990. New low-cost mine production from Portugal, increasing production in Bolivia, more or less stable production in Brazil, continued tin smuggling in Asian countries and a slowdown in global economic growth, are factors which should maintain production in excess of consumption.

The spirit of cooperation between ATPC members, Brazil and China is expected to deteriorate as tin producers are more concerned about maintaining their market shares in an excess supply environment. The emergence of major new producers with differing interests outside of southeast Asia (Brazil and Portugal) is reducing the industry's geographical concentration and cohesiveness.

Longer-term prospects for tin consumption are not buoyant. Tin in chemicals offers the best prospects but consumption of tinplate is likely to continue to fall slowly in the longer term.

Note: Information contained in this review was current as of mid-January 1990.

TARIFFS

Item No.	Description	Canada			United States	EEC	Japan[1]
		MFN	GPT	USA	Canada	MFN	MFN
2609.00	Tin ores and concentrates	Free	Free	Free	Free	Free	Free
7204.30	- Waste and scrap of tinned iron or steel	Free	Free	Free	Free	Free	Free
8001.10	- Tin, not alloyed	Free	Free	Free	Free	Free	Free
8001.20	- Tin alloys						
8001.20.10	--- Tin-antimony alloys	Free	Free	Free	Free	Free	3.2%
8001.20.20	--- Tin-lead-antimony alloys	6.8%	Free	Free	Free	Free	3.2%
8001.20.90	-- Other	10.2%	6.5%	Free	Free	Free	3.2%
8002.00	Tin waste and scrap	Free	Free	Free	Free	Free	Free
8003.00	Tin bars, rods, profiles and wire						
8003.00.10	--- Bars and rods, not alloyed or of tin-antimony alloys	Free	Free	Free	3.3%	3.2%	3.7%
8003.00.10.10	----- Not alloyed	Free	Free	Free	3.3%	3.2%	3.7%
8003.00.30	--- Bars and rods, of phosphor-tin alloys	5.5%	3.5%	3.3%	3.3%	3.2%	3.7%
8003.00.50	--- Bars and rods, of other alloys; profiles; other wire	10.2%	6.5%	6.1%	3.3%	3.2%	3.7%
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm						
8004.00.20	--- Of phosphor-tin alloys	5.5%	3.5%	3.3%	1.9%	2.5%	3.7%
8004.00.90	--- Other	10.2%	6.5%	6.1%	1.9%	2.5%	3.7%
8004.00.90.10	----- Not alloyed	10.2%	6.5%	6.1%	1.9%	2.5%	3.7%
8004.00.90.20	----- Of tin-antimony alloys	10.2%	6.5%	6.1%	1.9%	2.5%	3.7%
8004.00.90.90	----- Other	10.2%	6.5%	6.1%	1.9%	2.5%	3.7%
8005.20	- Powders and flakes						
8005.20.10	--- Powders, not alloyed	4%	Free	2.4%	3.3%	2.9%	4.9%
8005.20.20	--- Alloyed powders, flakes	10.2%	6.5%	6.1%	3.3%	2.9%	4.9%
8006.00	Tin tubes, pipes and tube or pipe fittings (i.e., couplings, elbows, sleeves)	10.2%	6.5%	6.1%	1.9%	4.5%	4.9%
8007.00	Other articles of tin	10.2%	6.5%	8.1%	2.7% to 3.7%	5.3%	5.8%
8007.00.00.10	----- Anodes for electroplating	10.2%	6.5%	8.1%	2.7% to 3.7%	5.3%	5.8%

Sources: Customs Tariffs, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Custom Tariff Schedules of Japan, 1989.

[1] GATT rate is shown, lower tariff rates may apply circumstantially.

Note: Where there is a tariff "range", a complete match of the HS code was not available; therefore, the high and low for the product in question is shown.

TABLE 1. CANADA, TIN PRODUCTION AND TRADE, 1988 AND 1989, CONSUMPTION 1987–89

Item No.		1988		1989p	
		(tonnes)	($000)	(tonnes)	($000)
Production					
Tin content of tin concentrates and lead-tin alloys		x	x	x	x
				(Jan.-Sept.)	
Exports					
2609.00	Tin ores and concentrates				
	Malaysia	1 360	4 674	1 241	5 199
	Singapore	45	241	598	1 944
	Mexico	521	2 807	434	3 814
	United Kingdom	1 665	15 322	70	815
	Total	3 591	23 045	2 343	11 772
7204.30	Waste and scrap of tinned iron or steel				
	United States	12 112	1 723	5 989	1 752
	Other countries	1 051	221	531	454
	Total	13 163	1 947	6 520	2 210
8001.10	Tin not alloyed unwrought				
	United States	131	909	41	459
	United Kingdom	. . .	4	2	23
	Total	132	914	42	483
8001.20	Tin alloys unwrought				
	United States	145	628	79	568
	Other countries	. . .	3	. . .	8
	Total	145	631	80	577
8002.00	Tin waste and scrap				
	United States	329	300	2 215	1 830
	Other countries	674	397	156	84
	Total	1 003	699	2 371	1 915
8003.00	Tin bars, rods, profiles and wire				
	United States	35	141	20	128
	Japan	. . .	2	3	2
	Total	35	143	23	131
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm				
	United States	1 064	1 701	340	589
	Taiwan	–	–	140	54
	Hong Kong	–	–	100	34
	Other countries	462	213	95	75
	Total	1 526	1 915	675	755
8005.20	Tin powders and flakes				
	South Korea	2	72	1	36
	Other countries	1	26	. . .	–
	Total	3	99	1	37

TABLE 1. (cont'd)

Item No.		1988		Jan.-Sept. 1989p	
		(tonnes)	($000)	(tonnes)	($000)
8007.00	Tin articles n.e.s.				
	United States	. .	2 198	. .	2 283
	Other countries	. .	189	. .	275
	Total	. .	2 390	. .	2 560
Imports					
2609.00	Tin ores and concentrates	21	14	49	49
7204.30	Waste and scrap of tinned iron or steel	58 761	4 867	44 554	4 258
8001.10	Tin, not alloyed unwrought	4 008	34 957	3 042	29 928
8001.20.10	Tin-antimony alloys	95	741	85	931
8001.20.20	Tin-lead antimony alloys	2	22	2	21
8001.20.90	Other tin alloys	27	245	5	51
8003.00.10.10	Bars and rods, not alloyed	124	1 132	151	1 611
8003.00.30	Bars and rods, of phosphor-tin alloys	1	10	. . .	2
8003.00.50	Bars and rods, of other alloys; profiles; other wire	16	191	42	545
8004.00	Tin plates, sheets and strip, of a thickness exceeding 0.2 mm	22	198	11	194
8005.20	Powders and flakes				
8005.20.10	Powders, not alloyed	12	147	9	113
8005.20.20	Alloyed powders, flakes	2	23	1	17
8006.00	Tin tubes, pipes and tube or pipe fittings	4	71	3	48
8007.00.00.10	Other articles of tin - anodes for electroplating	7	67	6	54

	1987	1988	1989e
		(tonnes)	
Consumption[1]			
Tinplate and tinning	1 883	1 797	1 706
Solder	1 351	1 360	1 379
Babbit	133	121	173
Bronze	274	195	246
Other uses (including collapsible containers, foil, etc.)	139	127	121
Total	3 780	3 600	3 626

Source: Statistics Canada.

[1] Available data as reported by consumers.

p Preliminary; x Confidential; e Estimated; n.e.s. Not elsewhere specified; – Nil; . . . Too small to be expressed; . . Not available.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, TIN PRODUCTION, TRADE[1] AND CONSUMPTION, 1970, 1975, 1980, 1983–89

	Production[2]	Exports[3]	Imports[4]	Consumption[5]
		(tonnes)		
1970	120	268	5 111	4 565
1975	319	1 052	4 487	4 315
1980	243	883	4 527	4 517
1983	140	371	3 769	3 371
1984	209	315	4 105	4 076
1985	119	358	3 696	3 966
1986	x	3 727	3 925	3 270r
1987	x	2 778	3 792	3 780
1988	x	3 591	4 376	3 600p
1989p	x	2 343[6]	3 326[6]	3 626e

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning 1988 Exports and Imports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Exports include HS class 2609.00. Imports include HS classes 8801.10, 8001.20.10, 8001.20.20, 8001.29.90, 8003.00.10.10, 8003.00.30 and 8003.00.50. [2] Tin content of tin concentrates shipped plus tin content in lead-tin alloys produced. [3] Tin in ores and concentrates and tin scrap, and re-exported primary tin. [4] Tin metal. [5] Current coverage exceeds 90%, whereas until 1972, coverage was in the order of 80-85%; available data as reported by consumers. [6] Exports and Imports are Jan.-Sept. figures.

p Preliminary; x Confidential; r Revised; e Estimated.

TABLE 3. WORLD TIN PRODUCTION, CONSUMPTION AND PRICES, 1975 and 1980-89

	Production			Prices[2]	
	Tin in Concentrate[1]	Primary Metal	Consumption	LME[3]	NY Dealer
		(000 t)		(US$/lb.)	
1975	181	179	173	3.12	3.40
1980	201	198	174	7.62	7.73
1981	205	197	163	6.52	6.48
1982	190	180	157	5.80	5.86
1983	172	159	155	5.89	6.01
1984	167	161	165	5.56	5.67
1985	158	155	160	5.57	5.25
1986	139	148	165	2.87	2.94
1987	138	148	172	3.10	3.15
1988	153	167	180	3.25	3.31
1989	. .	. .	. .	3.93	3.97

Source: International Tin Statistics.

[1] Excludes countries with centrally planned economies, except Czechoslovakia. [2] "Metals Week."

[3] London Metal Exchange. For 1987, 1988 and part of 1989, the "Europe Free Market" in warehouse Rotterdam prices were used to calculate averages.

. . Not available.

TABLE 4. WORLD[1] CONSUMPTION OF PRIMARY[2] TIN METAL, 1986–88

	1986	1987	1988
		(tonnes)	
EEC, total	41 799	47 281	50 712
West Germany	16 884	16 947	19 142
France	7 461	7 389	7 800
United Kingdom	6 000	6 200	6 400
Netherlands	4 009	4 600	4 660
Italy	4 560	6 000	6 000
Spain	2 600	2 600	2 800
Belgium Luxembourg	1 141	1 900	2 500
United States	32 548	35 620	37 008
Japan	31 521	32 600	32 200
Poland	3 624	2 700	3 500
Brazil	5 875	7 660	8 260
Canada	3 655	3 600	3 400
Czechoslovakia	3 200	3 200	3 200
Republic of Korea	4 335	4 500	5 000
Australia	2 460	2 280	2 380
Total, including Others	165 100	171 800	180 100

Source: International Tin Statistics.

[1] Excludes countries with centrally planned economies, except Bulgaria, Czechoslovakia, Hungary, Poland, Romania and Yugoslavia. [2] May include secondary tin in some countries.

TABLE 5. WORLD[1] PRODUCTION OF TIN-IN-CONCENTRATES, 1986–88

	1986	1987	1988
		(tonnes)	
Malaysia	29 134	30 388	28 866
Indonesia	24 634	26 093	29 589
Bolivia	10 479	8 128	10 541
Thailand	16 792	14 765	14 225
Brazil	25 449	28 523	42 800
Australia	8 470	7 710	7 009
United Kingdom	4 345	4 084	3 453
South Africa	2 055	1 438	1 362
Peru	4 817	5 263	4 378
Zaire	1 889	2 226	1 943
Total, including Others	139 200	137 600	153 000

Source: International Tin Statistics.

[1] Excludes countries with centrally planned economies, except Czechoslovakia.

TABLE 6. WORLD[1] PRODUCTION OF PRIMARY TIN METAL, 1986–88

	1986	1987	1988
		(tonnes)	
Malaysia	43 788	44 363	49 900
Indonesia	22 080	24 200	28 365
Thailand	19 672	15 438	14 650
Bolivia	7 673	2 610	5 491
Brazil	25 104	29 046	41 300
United Kingdom	9 227	12 135	9 014
Netherlands	5 114	3 824	3 463
Australia	1 399	563	439
Spain	1 725	1 431	656
United States	3 213	3 905	1 467
South Africa	1 816	1 608	2 330
Singapore	500	1 000	1 500
Nigeria	91	560	566
Total, including Others	148 000	147 600	166 500

Source: International Tin Statistics.

[1] Excludes countries with centrally planned economies.

TABLE 7. MONTHLY AVERAGE TIN PRICES[1], 1988 AND 1989

	N.Y. Dealer		London Metal Exchange	
	1989	1988	1989	1988
		(US$/lb.)		
January	3.46	3.18	3.44	3.16
February	3.63	3.15	3.60	3.10
March	4.08	3.19	4.03	3.13
April	4.71	3.19	4.67	3.11
May	4.73	3.22	4.68	3.13
June	4.67	3.31	4.61	3.21
July	4.48	3.35	4.43	3.29
August	4.01	3.43	3.99	3.37
September	3.63	3.45	3.78	3.39
October	3.72	3.39	3.67	3.33
November	3.19	3.42	3.16	3.38
December	3.16	3.43	3.11	3.39
Yearly average	3.97	3.31	3.93	3.25

Source: "Metals Week."

[1] From January 1988 to May 1989 the "Europe Free Market" prices were used.

Uranium

1989

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OVERVIEW

During 1989, uncertainty persisted in the world uranium industry, clouding the near-term market outlook. Among the factors that affected the market were: the offering in the West of natural and enriched uranium, or enrichment services, from the People's Republic of China and the U.S.S.R.; the sell-off or loaning of excess inventories, both in Western Europe and the United States; the alleged availability of uranium from some Eastern European countries; the possibility of changes to Australia's three-mine policy; and the relaxation of Australia's uranium floor-price policy. An additional complication has been the restriction of South African uranium imports by the United States and the prospect of restrictions being lifted on Namibian uranium following that country's independence. Some of these factors could well continue to influence the markets into the 1990s.

The market uncertainty has caused further layoffs and mine closures in the uranium industry, most notably in the United States, and has deferred some production decisions; in Canada, it has led to staff cut-backs, two extended mill closures, and the curtailment of refining and conversion activity. All of these uncertainties have contributed to a continuation of the uranium price slide; at year-end 1989, the Nuexco Exchange Value (EV) spot-price indicator hit an all-time low of US\$9.00/lb. U_3O_8.

Despite the general market weakness, Canada's uranium marketers signed new sales contracts for about 10 300 tU in 1989. Whereas prospects for a market upswing in the near term may seem remote, there are some indications to suggest a turnaround, perhaps before the late 1990s. First, buyers may have already begun to secure uranium under long-term contracts while prices are low. Second, the growing awareness that nuclear power plants do not contribute to acid rain or global warming could lead to a renaissance for nuclear power, although new capacity would not be in service until after the end of the century.

Any movement towards long-term contracting would bode well for the market as it would provide the reassurances needed to promote investment in exploration and in new production capacity. Most analysts predict the need for production from new uranium projects as early as the mid-1990s, but the precise timing of these needs is uncertain. Uranium requirements in the western world are projected to approach 50 000 tU/y before the year 2000; annual production is currently around 37 000 tU, well below that requirement level.

PRODUCTION AND DEVELOPMENT

Throughout the 1980s, the decline in uranium prices and the efforts to constrain production costs have led to a reduction in Canada's uranium industry workforce. In January 1989, over 4700 employees worked at the country's uranium-producing operations, a drop of more than 20% in just four years. The output and employment data for Canada's uranium producers for 1987 and 1988 are summarized in Table 1. Figure 1 illustrates the output and ownership share of Canada's uranium production centres in 1988.

The preliminary estimate of uranium production in 1989 from Canada's five primary producers is 11 300 tU, a 10% drop from the 1988 level; it reflects extended mill closures made in line with the efforts to match output with sales commitments. Figure 2 locates Canada's existing producers and major uranium deposits.

Uranium shipments from Canada's five producers remain high. As shown in Table 2, the preliminary estimate of 1989 shipments made by these producers is 11 564 tU, worth about \$990 million. The difference between the annual production and shipment figures reflects inventory adjustments by the producers. Two thirds of Canada's uranium output and shipments comes from Saskatchewan, and the balance comes from Ontario. As domestic requirements represent only about 15% of current Canadian output, most of Canada's uranium production is available for export.

Table 3 lists the operational characteristics of Canada's existing uranium production centres in 1988.

Elliot Lake, Ontario

Denison Mines Limited and Rio Algom Limited each augmented primary production with output from in-place (mine) leaching and from the processing of refinery/conversion wastes. The secondary recovery of more than 70 tU by these producers helped to push Canada's overall output to a record 12 470 tU in 1988. Declining prices have caused both producers to continue programs aimed at cutting costs and improving operating efficiency in an effort to remain competitive. Rio Algom and Denison have been producing under long-term contracts with Ontario Hydro and various export customers; deliveries under the principal export contracts will be completed in the 1990s and, unless they are replaced, production levels could decline significantly.

Denison hoisted the first development ore from its adjoining Canuc property in late 1988, and production mining began in 1989. Mill throughput improved in the third quarter with the resolution of a mechanical problem in the surface ore-grinding facility. A temporary shortage of jack-leg miners resulted in the mining of lower-than-planned ore grades and a consequent reduction in overall uranium production; output for the first nine months of 1989 approached 1250 tU.

Rio Algom continued ore development work at the properties tributary to its Stanleigh operation; de-watering of the Milliken mine was targeted for completion early in 1990. With production geared to contract commitments, Rio Algom's overall output in 1989 was expected to be slightly below the 1988 level.

With a long-term view, Rio Algom purchased low production-cost properties in New Mexico and Wyoming from the Kerr-McGee Corporation early in 1989. In October, the company signed a non-binding letter of intent to buy another U.S. producer, Uranium Resources, Inc., but terminated the offer late in the year. Rio Algom closed its first U.S. uranium mine, at Moab, Utah, late in 1988 after 16 years of operation, but placed the mill on stand-by.

Athabasca Basin, Saskatchewan

In 1989, Cameco - A Canadian Mining & Energy Corporation withdrew from the spot market because of the depressed state of the general market. In March, it announced the shutdown of its Rabbit Lake mill for at least six months beginning in July. This decision affected 96 mine-site positions but should help the company reduce its inventories. Efforts were redirected towards upgrading the solvent extraction plant to handle ore from the Eagle Point deposit, and increasing the capacity at the Rabbit Lake mill to about 4600 tU/y; output up to the mid-year closure was about 1790 tU. At Eagle Point South, development work is under way in anticipation of the early 1990s production, at a rate determined by the markets; approval to construct the surface facilities was received in April and the mine access ramp was collared by year-end.

At Cluff Lake, mining was completed at the Claude open pit in June, and overburden removal was accelerated at the Dominique-Janine open pit; production from the new North pit began in 1989. The Cluff Mining partnership again geared output to sales as in 1988, when the mill operated every other week; in the first six months of 1989, output neared 630 tU. A mid-year announcement of an extended mill closure from October 1989 to February 1990 will not likely affect production targets for 1990. Mining of the Dominique-Peter underground mine, which had been resumed in April 1989, was suspended when the mill shutdown announcement was made.

In January 1989, Key Lake Mining Corporation (KLMC) began production mining of its larger Deilmann orebody, blending this ore with stockpiled low-grade Gaertner ore. KLMC produced more than 2600 tU, or 10% over its year-to-date target, in the first six months of 1989. As the ore at Deilmann is more contaminated with molybdenum than was the Gaertner ore, a special mill circuit was installed in mid-1989 to remove molybdenum and thereby maintain the uranium concentrate quality. In March 1989, it was agreed that Cameco would become operator of the Key Lake mine. Consolidation of Saskatoon-based support services of the Key Lake and Rabbit Lake operations will reduce operating costs.

Additional Production Possibilities

In northeastern Saskatchewan, Cigar Lake Mining Corporation (CLMC) began shaft sinking in September 1988 and expects to complete its 500 m-deep shaft during 1990. Lateral drifts from the 420 m level will permit test mining before final feasibility studies in 1990/91. Below the 315 m level, grouting was required to stop water inflow; the mine water treatment plant began continuous operation in March, handling 180 gallons/minute. The project continues on schedule and within budget; development expenditures to mid-1989 approached $6 million. While start-up is dependent on the markets, initial output is not anticipated before 1993.

The Midwest Joint Venture completed its 185 m-deep shaft in northeastern Saskatchewan in April 1989 and began lateral drifting into the orebody to test the blind-hole boring method. In October, the underground test mining program had been completed. As project operator, Denison must evaluate the test results and expects to make a recommendation to its partners before the end of 1990 regarding a production decision. An updated capital and operating cost estimate report has been completed and preparation of an Environmental Impact Statement (EIS), required for pre-production regulatory approvals, is under way. Denison is also maintaining its Koongarra property in Australia's Northern Territory in good standing in anticipation of a change in that country's three-mine policy.

Near Baker Lake, Northwest Territories, Urangesellschaft Canada Limited hopes to develop its Kiggavik project for production in the mid-1990s; any decision to proceed with the project depends on the uranium market, the results of an environmental review process now under way, and the search for other joint venture partners. In June 1989, a federal government-appointed Environmental Assessment Review Panel set guidelines for an EIS. The EIS was completed late in 1989 and submitted in January 1990; public hearings are scheduled following review of the EIS by the Panel.

EXPLORATION

In 1989, Energy, Mines and Resources' (EMR) Uranium Resource Appraisal Group (URAG) completed its fifteenth annual assessment of Canada's uranium supply capabilities and an associated survey of exploration activity. The results were reported[1] in late 1989. Table 4 summarizes uranium exploration activity in Canada from 1976 to 1988; interestingly, the number of "million-dollar" projects has stayed relatively constant over the period 1982 to 1988.

URAG reported that uranium exploration in 1988 jumped to $59 million from about $37 million in 1987. The increase is due mainly to test mining programs at the Cigar Lake and Midwest uranium projects in northern Saskatchewan; this work is deemed to be part of the advanced exploration activity at these two sites. Exploration drilling increased by 22% to over 200 000 m, with activity centred on developed and proven properties.

Exploration successes at several recently discovered deposits, mainly in northern Saskatchewan, added to Canada's overall uranium resources; these additions were **not** sufficient to replace the record production of 1987 and 1988.

Over 30 companies participated in 54 active exploration projects managed by 14 operators. The 10 most active operators[2] in 1988 spent 98% of the $59 million total expenditure. In alphabetical order they were: Amok Ltd., Cameco - A Canadian Mining & Energy Corporation, Cigar Lake Mining Corporation, Cogema Canada Limited, Denison Mines Limited, Interuranium Canada Limited, Minatco Ltd., PNC Exploration (Canada) Co. Ltd., Uranerz Exploration and Mining Limited and Urangesellschaft Canada Limited.

In Saskatchewan, 1988 uranium exploration efforts were focussed i) in the southeastern part of the Athabasca Basin, between Key Lake and Cigar Lake; ii) along the Eagle Point and Collins Bay faults; iii) in the northeastern part of the Basin, on the Wolly Block; iv) on the Carswell Structure of the western Athabasca Basin; and v) at the western limit of the Basin in northern Alberta. In the Northwest Territories, the greatest exploration effort was conducted on the northeast margin of the Thelon Basin.

Many exploration programs are now based on the application of conceptual genetic models, postulating deposit association with Proterozoic unconformities and with granitic basement domes. Together with structural and lithological analysis, these methods led to Cameco's discovery of mineralization on the McArthur River property in Saskatchewan, between Key Lake and Cigar Lake. Here, uranium mineralization has been traced by means of 17 holes along a strike length of 1100 m; grades up to 12% U over 18 m have so far been recorded. In Alberta's Maybelle River area, at the western margin of the Athabasca Basin, polymetallic uranium mineralization was discovered associated with the sub-Athabasca unconformity.

GOVERNMENT INITIATIVES

Privatization of Cameco

On September 30, 1988, the Canadian and Saskatchewan governments merged Eldorado Nuclear Limited and Saskatchewan Mining Development Corporation (SMDC), their respective Crown companies involved in the uranium business. Formation of the new company, Cameco - A

Canadian Mining & Energy Corporation, was the first step in the privatization of both governments' uranium interests.

The respective shareholdings in Cameco were to be reduced by 100% on a phased basis over seven years through a public share offering. However, in early 1989, Cameco indicated that privatization would be deferred for at least one year due to the depressed state of the uranium market. Reportedly, Cameco is considering selling uranium resources to reduce its debt, thereby enhancing its position, and the Saskatchewan government is rethinking the privatization issue because of public concerns regarding the sale of Saskatchewan Crown corporations.

U.S. Import Restrictions

The U.S. Atomic Energy Act requires that the Department of Commerce conduct a national security investigation (under Section 232 of the U.S. Trade Expansion Act) if uranium imports exceed 37.5% for two successive years. This occurred in 1986 and 1987, precipitating the initiation of a national security investigation in early 1989.

The Commerce Department's final report was submitted to President Bush in September and to the Congress in October. It concludes that imports of foreign uranium at the current level (about 50%) **do not** present a threat to national security, a conclusion based, at least in part, on the fact that a majority of the imports come from Canada.

This ruling, coupled with the Canada-U.S. Free Trade Agreement implemented in January 1989, provides Canada's uranium producers with enhanced access to the large U.S. market.

Atomic Energy Control Board (AECB) Cost Recovery

In 1987, the Government of Canada requested that the AECB carry out a study to assess the potential financial impacts of recovering its costs from its licensees, and a feasibility study for total cost-recovery was initiated. Financial information and comments from the uranium and nuclear industries have assisted the AECB in preparing a report to the Government on the impacts of the proposal on those who would have to pay.

User fees collected under a cost-recovery regime would be deposited into the Consolidated Revenue Fund and would **not** be directly available to the AECB. Its resource requirements would remain under the control of the central agencies, and any budget increases to the AECB would have to be justified to, and approved by, the Treasury Board.

The proposed regulations and fee schedule were pre-published in the Canada Gazette early in January 1990, and users were given 30 days to respond. It was expected that the final version would be prepared, and published in the Gazette, in time to allow fees to be levied beginning on April 1, 1990. One half of the fee revenue collected would come from the nuclear utilities, 20% from the uranium industry, and the remainder from other sources.

New Radiation Exposure Limits for Canadian Uranium Mines

The AECB recently completed a review of radiation exposure limits in Canadian underground uranium mines and recommended changes to the regulations. The proposed "acceptable radiation limit" will measure the total cumulative dosage in determining radiation exposure levels. The new rules will replace the current system, which measures radiation exposure on a separate-source basis, i.e., exposures from different sources are monitored separately and are not added together. The proposed date for implementation of the revised AECB regulations is 1991.

Charges Against Cameco for the Rabbit Lake Spill

On November 7, 1989, a 2000 m^3 spill of slightly radioactive rain and ground water from the Collins Bay B orebody was discovered at Cameco's Rabbit Lake operation in northern Saskatchewan. A full investigation carried out by both the Saskatchewan Department of the Environment and Public Safety and the AECB confirmed that no degradation of water quality in Wollaston Lake occurred because of the spill; the incident was serious in terms of volume but not in terms of contaminants. All parties recognized that the spill should not have happened, and the AECB has implemented a number of changes to its licensing and inspection practices.

In early December, the AECB charged Cameco with violations of the Atomic Energy Control Act, and the company was subsequently fined $10 000. The Saskatchewan government announced a separate but similar action, referring the investigation to the Saskatchewan Department of Justice to determine if sufficient evidence exists to lay charges under the provincial Environmental Management and Protection Act. It was expected that charges would be laid early in 1990.

Australian Uranium Floor Price

On September 4, 1989, the Australian Government's Primary Industries and Energy Minister, John Kerin, announced that he had approved the renegotiation of pricing arrangements for long-term uranium contracts between Energy Resources of Australia Ltd. and a Japanese and a Swedish utility. The approval marked the first official indication that Australia was willing to move away from its long-held floor price, understood to be US$31.00/lb. U_3O_8.

While it was emphasized that the floor price requirements in all other existing contracts would remain unchanged, the floor for new contracts would be determined at a level which reflected the national interest in particular circumstances and market conditions in which the contracts are negotiated.

Nuclear Co-operation Agreement with the U.S.S.R.

In November 1989, Canadian and Soviet government officials signed a new Canada/U.S.S.R. Nuclear Co-operation Agreement that contains many of the features common to agreements with Canada's other nuclear partners. It includes an accord that nuclear equipment, material and technology that becomes subject to the agreement will not be used for any nuclear explosive device or other military purpose. It will permit significant expansion of Canada/U.S.S.R. nuclear relations as opportunities emerge, in the field of nuclear safety, for example.

RESOURCES

Canadian uranium supply over the next decade will be drawn from known resources, estimates of which are divided into three major categories, measured, indicated and inferred, that reflect different levels of confidence in the reported quantities. Most of these resources are associated with deposits identified in Figure 2.

The current estimates of resources in these categories, as prepared by EMR's URAG, are presented in Table 5. As of January 1, 1989, Canada's total recoverable known uranium resources were estimated at 544 000 tU, down from the 567 000 tU reported at the beginning of 1987. The actual production draw-down of reserves, most notably those at low-cost levels, is reflected in a net decline in all three categories of known resources. Further comparison of the current resource estimates with those reported previously indicates that the resource additions from new discoveries did not replace the record output over the two-year assessment period.

Of Canada's total known resources presented in Table 5, half occur in unconformity-related type deposits, mainly in northern Saskatchewan. These contain either monometallic (Eagle Point) or polymetallic (Key Lake and Cigar Lake) mineralization associated with the sub-Athabasca unconformity.

In monometallic deposits, the mineral pitchblende prevails whereas in polymetallic deposits, uranium-nickel-cobalt assemblages are usually predominant. Average grades can vary from below 1% U to between 2 and 5% U, while in parts of certain deposits (Cigar Lake) grades can exceed 10% U.

SUPPLY CAPABILITY

Production capability from Canada's existing operations is now expected to remain at about 12 000 tU/y through the early 1990s, provided that the market slump does not lead to the premature closure of certain higher-cost mines. Actual output could be lower if producers avoid the spot market and continue to gear production to their existing contract commitments. At some mines, higher uranium prices will be required to bring production back up to the capability levels of the mid-1980s.

To illustrate Canadian uranium availability in the short term, Figure 3 provides two projections of production capability. The upper curve assumes a level of production that could be realistically expected, supported by known resources recoverable at prices of $150/kgU or less. The lower curve is based only on resources in the so-called low-cost category, i.e., $100/kgU or less. No commitments have been made for the start-up of any production centres beyond those currently in operation.

Depending on developments in the international uranium market, certain projects noted above could be brought on-stream to increase total Canadian production capability beyond 15 000 tU/y by the mid-1990s. Costs associated with some of these possible new production centres are currently uncertain.

MARKETS AND PRICES

Canada has maintained its position as the world's leading producer of uranium, as shown in Table 6. The Canada-U.S. Free Trade Agreement, implemented early in January 1989, has provided uranium producers in Canada with enhanced access to the U.S. market, still the largest in terms of uncommitted demand. Despite the general market uncertainty, Canada's uranium marketers signed new sales contracts for about 10 300 tU in 1989. Utilities in the United States negotiated the bulk of this new 1989 sales volume, most of it under long-term contracts. Such long-term commitments are critical to the viability of the uranium industry, both in Canada and abroad.

Table 7 indicates the total amount of uranium under Canadian export contracts approved since 1974, and illustrates Canada's diverse export base. As of January 1, 1990, forward commitments under all export and domestic contracts exceeded 60 000 tU and 70 000 tU, respectively.

In Canada, the average price of all export deliveries in 1989 was C$74/kgU, about 6% lower than that reported for the previous two years. Only 1% of total export deliveries made by Canadian producers in 1989 were under spot sales, compared with 13% in 1988, 35% in 1987, 21% in 1986, and 1.5% in 1982. The average price of Canadian export deliveries for the period 1974 to 1989 is shown in Table 8.

Uranium spot market prices remained well below Canada's 1989 average export price, which in U.S. dollar terms was $24/lb. U_3O_8. The continuing uranium price slide saw the Nuexco Exchange Value[3] (EV) spot-price indicator hit a record low of US$9.00/lb. U_3O_8 in December 1989.

Actual uranium exports in 1989 are expected to match those of 1988. Table 9 summarizes exports of Canadian-origin uranium from 1984 to 1988 for Canada's principal export customers, while Tables 10 and 11 tabulate recent values of Canadian exports of radioactive ores and concentrates and radioactive elements and isotopes reported by Statistics Canada. Figure 4 illustrates the future importance of Canada's export markets in terms of forward scheduled deliveries of uranium in concentrates.

REFINING

Cameco operates Canada's only uranium refining and conversion facilities, located at Blind River and Port Hope, Ontario, respectively. At the Blind River refinery, production of uranium trioxide (UO_3), an intermediate product, has steadily increased each year since start-up; output in 1988 approached 11 500 tU as UO_3. Circuit optimization/testing in 1988 showed that the refinery can operate above its nameplate capacity of 18 000 tU/y and still maintain high standards of quality, safety and environmental protection.

Between February and late April 1989, refinery throughput was reduced significantly for equipment repairs, but the slow-down did not affect operations at Port Hope. In March, it was announced that the refinery work force would be reduced by about 20% (36 out of 165) as a result of expected production cutbacks for 1989 and improved operating efficiencies. The refinery closed during July for maintenance, semi-annual inventory and vacations.

The Port Hope facilities convert the UO_3 to either uranium hexafluoride (UF_6), for use in foreign light-water reactors following enrichment, or uranium dioxide (UO_2), for use in CANDU reactors. The new UF_6 conversion plant, with an annual capacity of 10 500 tU as UF_6, represents the primary Port Hope activity. In 1988, output of UF_6 reached its highest level since the plant was commissioned in 1984. The expanded UO_2 facility, completed in 1980, has a capacity of about 2700 tU as UO_2. Overall, some 11 250 tU was converted in 1988, up slightly from 1987. In March 1989, it was also announced that the Port Hope work force would be reduced by about 10% (40 of 350).

In the first six months of 1989, production and quality targets for both UF_6 and UO_2 were achieved. Because of lower market requirements and high inventories, both plants worked on a 10-day operating, 4-day shutdown schedule during 1989, as opposed to the usual 24-hour, 7-day per week schedule.

In mid-December 1989, Cameco announced that it would extend to four months the annual summer shutdown at its Blind River and Port Hope facilities in mid-1990. The measure was necessitated by market conditions in which contract commitments and anticipated demand continue to lag below production capabilities.

Two smaller operations at Port Hope produce and process depleted uranium metal and perfluorocarbons. Depleted uranium is used in the medical, aerospace and nuclear industries as ballast and shielding, while perfluorocarbons, after purification in the United Kingdom, are used for vapour-phase soldering in electronic circuit board manufacturing, electronics testing and cooling.

NUCLEAR POWER DEVELOPMENTS

According to the 1989 "Brown Book," Nuclear Energy Data, published by the Nuclear Energy Agency of the Organisation for Economic Co-operation and Development (OECD), installed nuclear generating capacity in OECD countries exceeded 247 000 megawatts electric (MWe) in 1988, and was expected to approach 290 000 MWe by 1995, and 315 000 MWe by 2005. Estimates of reactor-related uranium requirements for installed capacity in the OECD were about 39 100 tU, 39 600 tU, and 46 700 tU for the years 1988, 1995 and 2005, respectively.

At the end of 1989, 18 CANDU reactors with a combined generating capacity of about 12 000 MWe were in service in Canada, as shown in Table 12; four reactors under construction at the Darlington site east of Toronto will enter service between 1990 and 1992, adding almost 3400 MWe to the Ontario Hydro grid. In addition, a second CANDU reactor is envisaged for Point Lepreau, New Brunswick, another four-CANDU station could be built at Darlington, and talks are under way toward a CANDU 3 reactor in Saskatchewan. In 1989, over 16% of Canada's electric power was nuclear-generated, while in Ontario it was almost one half, and in New Brunswick over one third.

Ontario Hydro reported that since its first reactor at Pickering began operating in 1971, the use of nuclear energy has avoided the need to burn about 200 Mt of coal, worth $15 billion, and that the net savings to the utility, in constant (1989) dollars, is estimated at almost $6 billion.

Unit 2 of Ontario Hydro's Darlington A Station attained criticality on November 5, 1989, received its 20% power licence by year-end, and is expected to be in service in February 1990. Units 1, 3 and 4 are scheduled to be in service in late 1990, 1991 and 1992, respectively, by which time Ontario will be receiving 60% of its electricity from nuclear energy.

The CANDU nuclear reactor at Point Lepreau, New Brunswick, continues to perform very well, achieving a 95% operating capacity factor in 1989; since start-up in 1983, its capacity factor has averaged 93% making Point Lepreau the top performing CANDU in the world. To mid-year 1989, it was ranked third, in terms of lifetime operation, among the more than 260 commercial power reactors of 500 MWe size or greater in service worldwide.

OUTLOOK

The future of nuclear power beyond the year 2000 could be affected by decisions taken in the next decade with regard to the environment. There is a growing awareness that nuclear power plants do not contribute to global warming, as do fossil-fuel plants. The rising concern about emissions of CO_2 and other gases that contribute to the greenhouse effect could result in an increase in orders for nuclear power plants, and lead to a reversal of the recent downward trend in nuclear power capacity projections.

Canada has been a reliable uranium supplier to the world market for more than 40 years, and the Canadian government is committed to maintaining that role. Given its production capabilities and potential for additional discoveries, there is every reason to be confident that Canada can maintain its leading role in the world uranium market, while continuing to supply its domestic needs.

REFERENCES

[1] "Canadian Uranium Production at Record Levels" - News Release 89/117, EMR Canada, September 18, 1989.

[2] In certain cases, the identified operator has reported the total expenditures of a joint-venture effort. Therefore, contributions by other parties not responding to the URAG survey are accounted for in the $59 million total.

[3] The price at which transactions for significant quantities of natural concentrates could be concluded as of the last day of the month according to the Nuclear Exchange Corporation (Nuexco), a Colorado-based uranium brokerage firm.

Note: Information contained in this review was current as of mid-January 1990.

TABLE 1. URANIUM PRODUCTION IN CANADA AND WORK FORCE SUMMARY, 1987 AND 1988

Province and Producer	Total Work Force[1] (Dec. 31)		Annual Output (tU)	
	1987	1988	1987	1988
Athabasca Basin, Saskatchewan				
Key Lake Mining Corporation	400	440	5 199	4 629
Cameco - A Canadian Mining & Energy Corporation	370	350	2 193	2 679
Cluff Mining	200	180	829	860
Sub-total	970	970	8 221	7 168
Elliot Lake, Ontario				
Denison Mines Limited	1 670	1 670	1 809	1 876
Rio Algom Limited				
- Quirke	1 080	1 050	1 108	1 112
- Panel	620	570	826	769
- Stanleigh	490	470	471	468
Sub-total	3 860	3 760	4 214	4 225
Totals	4 830	4 730	12 435	12 393[2]

Sources: Company annual reports and Atomic Energy Control Board open files.

[1] Figures have been rounded [2] Primary output: an additional 73 tU was recovered by Elliot Lake producers from refinery conversion facility wastes.

TABLE 2. VALUE OF URANIUM SHIPMENTS[1] BY PROVINCE, 1986–89

	1986	1987	1988	1989p
Ontario producer shipments (tU)	4 752	4 901	3 872	3 980
Value of shipments ($ million)	566	581	446	460
Saskatchewan producer shipments (tU)	6 750	8 711	8 194	7 584
Value of shipments ($ million)	476	601	572	530
Total producer shipments (tU)	11 502	13 612	12 066	11 564
Total value of shipments ($ million)	1 042	1 182	1 018	990

[1] Shipments in tonnes of uranium (tU), contained in concentrate, from ore processing plants.
p Preliminary.

TABLE 3. OPERATIONAL CHARACTERISTICS OF EXISTING CANADIAN URANIUM PRODUCTION CENTRES, 1988

Company/ Facility/ Name	Ore-processing Plant[1]			
	Capacity	Recovery	Annual Throughput	
	Nameplate/ Actual	Overall	Ore Total	Ore Grade
	(t/d)	(%)	(t)	(% U)
Cluff Mining/ Cluff Lake	+ 900/ 1 000	96	183 000	0.49
Denison Mines Limited/ Elliot Lake	7 700/ 7 600	94	2 572 000	0.08
Cameco - A Canadian Mining & Energy Corporation/ Rabbit Lake	1 800/ 1 600	96	388 600	0.72
Key Lake Mining Corporation/ Key Lake	+ 700/ + 700	98	242 000	1.94
Rio Algom Limited/ Elliot Lake				
Quirke	5 000 4 500	94	1 525 000	0.08
Panel	3 000 3 000	95	978 000	0.08
Stanleigh	+ 4 500 2 900	95	652 000	0.07

Sources: Corporate annual reports and the Atomic Energy Control Board (AECB).

[1] Figures have been rounded.

TABLE 4. URANIUM EXPLORATION ACTIVITY IN CANADA, 1976-88

Year	Expenditures[1]	Drilling[2]	Million-Dollar Projects[3]
	($ million)	(km)	
1976	44	155	4
1978	90	334	7
1980	128	503	24
1982	71	247	13
1984	35	197	12
1986	33	162	11
1987	37	164	12
1988	59	201	11

[1] Direct exploration and drilling expenditures in current dollars. [2] Exploration and surface development drilling; excludes development on producing properties. [3] Number of projects where direct exploration and drilling expenditures exceeded $1 million in current dollars.

TABLE 5. ESTIMATES OF CANADA'S URANIUM RESOURCES RECOVERABLE FROM MINEABLE ORE[1], 1987 AND 1989[2]

Price Ranges Within Which Mineable Ore is Assessed[3]	Measured		Indicated		Inferred	
	1987	1989	1987	1989	1987	1989
	(000 tU)					
A	46	41	107	98	112	109
B	1	2	95	94	99	95
A + B	47	43	202	192	211	204
C	23	22	33	32	51	51
A + B + C	70	65	235	224	262	255

[1] Actual or expected losses in mining recovery and ore processing have been accounted for; these factors were individually applied to resources tributary to existing or prospective production centres. In underground operations, mineable ore is generally 75 to 85% of the ore in place; higher mining recoveries are achievable in open-pit operations. Ore-processing recoveries in Canada normally range from 90 to 97%; Canada's weighted average mill recovery for existing conventional uranium operations was 96% in 1988. [2] Numbers are for January 1, 1987 and January 1, 1989. [3] The price ranges are (A) $100 kgU or less, (B) between $100 and $150 kgU and (C) between $150 and $300 kgU. The Canadian dollar figures reflect the price of a quantity of uranium concentrate containing 1 kg of elemental uranium. The prices were used in determining the cut-off grade at each deposit assessed, taking into account the mining method used and the processing losses expected. The price of $100 kgU was used by URAG to illustrate those resources that were of economic interest to Canada in 1986 and 1988.

Note: $1 lb U_3O_8 = $2.6 kgU

TABLE 6. PRODUCTION OF URANIUM IN CONCENTRATES BY MAJOR PRODUCING COUNTRIES, 1983–88

	1983	1984	1985	1986	1987	1988
	(tonnes U)					
Canada	7 140	11 170	10 880	11 720	12 440	12 470
United States	8 140	5 720	4 350	5 200	5 000	5 190
South Africa	6 060	5 740	4 880	4 610	3 960	3 850
Namibia	3 720	3 690	3 600	3 300	3 540	3 600
Australia	3 210	4 390	3 250	4 150	3 780	3 530
Niger	3 470	3 400	3 180	3 110	3 000	2 970
France	3 270	3 170	3 200	3 250	3 380	3 390
Gabon	1 040	1 000	940	900	800	930
Other[1]	900	950	900	870	890	910
Total[2]	36 950	39 230	35 180	37 110	36 790	36 840

Sources: "Uranium: Resources, Production and Demand", a report jointly produced by the Nuclear Energy Agency of the OECD and the International Atomic Energy Agency, and miscellaneous national and international reports. Country figures are rounded to the nearest 10 tU.

[1] Includes Argentina, Belgium, Brazil, the Federal Republic of Germany, India, Israel, Japan, Portugal, Spain and Yugoslavia. [2] Totals are of the listed figures only.

TABLE 7. CANADIAN URANIUM UNDER EXPORT CONTRACT[1]

Country of Buyer[2]	Tonnes U
Belgium	3 350
Finland	3 512
France	9 715
Italy	1 115
Japan	27 181
South Korea	6 903
Spain	3 559
Sweden	8 977
Switzerland	154
United Kingdom	8 293
United States	66 032
West Germany	14 950
Total	153 741

[1] The quantity of uranium specified in all contracts reviewed and accepted under Canadian uranium export policy since September 5, 1974. Country totals are adjusted to reflect new and amended contracts as of December 31, 1989. [2] In most cases, indicates country of end-user.

TABLE 8. CANADIAN URANIUM EXPORT PRICE[1], 1974–89

Year	Average Export Prices Current Dollars	Average Export Prices Constant 1989 Dollars[2]	Spot Sale Portion of Deliveries
	($/kgU)		(%)
1974	39	100	nr
1975	52	121	nr
1976	104	223	nr
1977	110	222	nr
1978	125	238	nr
1979	130	225	nr
1980	135	211	nr
1981	110	155	1
1982	113	147	1½
1983	98	121	10
1984	90	108	26
1985	91	106	20
1986	89	102	21
1987	79	86	35
1988	79	83	13
1989	74	74	1

[1] EMR's Uranium Resource Appraisal Group (URAG) derives the Export Price figure annually. It is based on the average price under all export contracts made by Canadian producers for deliveries in the given year; prices are rounded. [2] The constant dollar values are derived using the Implicit Price Index for Gross Domestic Product.
nr Not reported.

TABLE 9. EXPORTS OF URANIUM OF CANADIAN ORIGIN, 1984-88

Country of Final Destination	1984	1985	1986	1987	1988
	(tonnes of contained uranium[1])				
Belgium	121	157	63	–	153
Finland	137	81	116	142	151
France	525	612	1 013	1 438	964
Italy	50	53	301	293	–
Japan	2 436	1 799	816	1 317	717
Netherlands	–	–	85	40	–
South Korea	30	194	402	828	874
Spain	–	–	150	150	100
Sweden	254	514	449	377	783
Turkey	–	–	2	–	–
United Kingdom	692	685	700	824	1 204
United States	2 397	3 524	3 692	6 063	4 682
West Germany	295	269	654	1 317	806
Total	6 937	7 888	8 443	12 789	10 434

Source: Atomic Energy Control Board.

[1] Some of this uranium was first exported to an intermediate country, for conversion and or enrichment, prior to transfer to the country of final destination.

– Nil.

TABLE 10. VALUE OF EXPORTS[1] OF RADIOACTIVE ORES AND CONCENTRATES[2] FROM CANADA, 1982-87

Country of Initial Destination	1982	1983	1984	1985	1986	1987
			($000)			
United States[3]	346 891	25 400	295 686	98 086	127 418	226 596
United Kingdom	11 690	37 175	28 188	113 753	19 893	25 812
Japan	–	–	3 475	15 514	–	–
West Germany	–	–	6 149	1 823	–	–
France	–	–	36	4 418	19 054	23 943
South Korea	–	–	–	–	461	893
Netherlands	–	–	167	–	–	798
Other	–	–	2	–	–	8
Total	358 581	62 575	333 703	233 594	166 826	278 050

Source: Statistics Canada.

[1] Material clearing customs with destinations as indicated. [2] Primarily uranium in concentrates, i.e., yellowcake. [3] Includes sales to the United States, as well as material destined for transshipment, primarily to Western Europe and Japan, following conversion and enrichment in the United States.

TABLE 11. VALUE OF EXPORTS[1] OF RADIOACTIVE ELEMENTS[2] AND ISOTOPES FROM CANADA, 1982-87

Country of Initial Destination	1982	1983	1984	1985	1986	1987
				($000)		
United States[3]	299 246	261 168	416 670	434 183	437 709	351 197
France	36 213	39 037	28 988	77 492	144 629	135 796
United Kingdom	796	2 303	1 601	22 174	6 056	26 935
Japan	19 617	12 371	35 729	35 892	6 624	12 119
West Germany	37 250	32 208	14 364	3 892	29 561	41 254
Italy	325	193	527	4 908	13 324	3 998
U.S.S.R.[4]	34 854	8 148	–	–	–	–
Netherlands	45	1 517	598	702	18 136	8 590
Finland	199	11	20 128	5 437	7 095	7 938
Argentina	214	315	520	1 305	1 136	1 163
South Korea	123	3 057	8 311	150	310	7 777
Other	5 151	7 287	13 256	4 943	10 024	11 477
Total	434 033	367 615	540 700	591 078	674 604	608 244

Source: Statistics Canada.

[1] Material clearing customs with destinations as indicated. [2] Includes uranium hexafluoride (UF_6) and radio-isotopes for medical and industrial purposes. [3] UF_6 component includes sales to the United States, as well as material destined for transshipment, primarily to Western Europe and Japan, following enrichment. [4] UF_6 component destined entirely for transshipment to Western Europe, following enrichment.

– Nil.

TABLE 12. NUCLEAR POWER PLANTS IN CANADA[1]

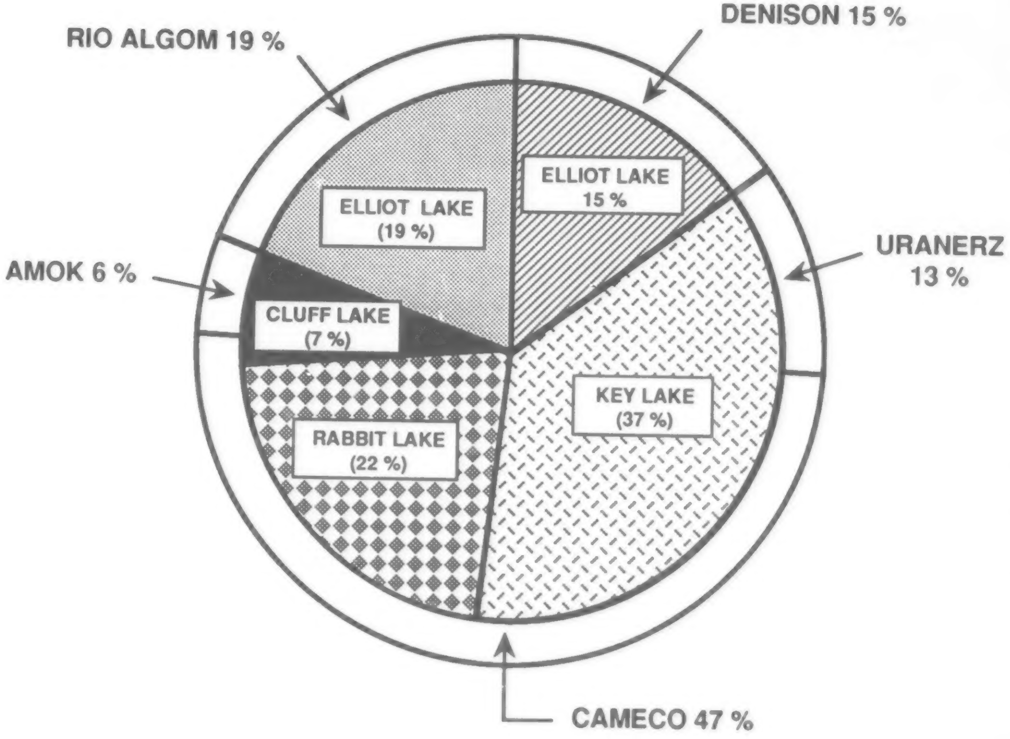
Reactors	Owner	Net Capacity	In-service Dates
		(MWe)	
Pickering 1 to 4	Ontario Hydro	2 060	1971-73
Bruce 1 to 4	Ontario Hydro	3 066	1977-79
Point Lepreau	NBEPC[2]	635	1983
Gentilly 2	Hydro-Québec	638	1983
Pickering 5 to 8	Ontario Hydro	2 064	1983-86
Bruce 5 to 8	Ontario Hydro	3 394	1984-87
Darlington 1 to 4	Ontario Hydro	3 524	1990-92●
Total net capacity expected by 1993		15 381	

[1] As of December 1989. [2] The New Brunswick Electric Power Commission.

● Expected.

Figure 1

CANADIAN URANIUM PRODUCTION AND OWNERSHIP 1988

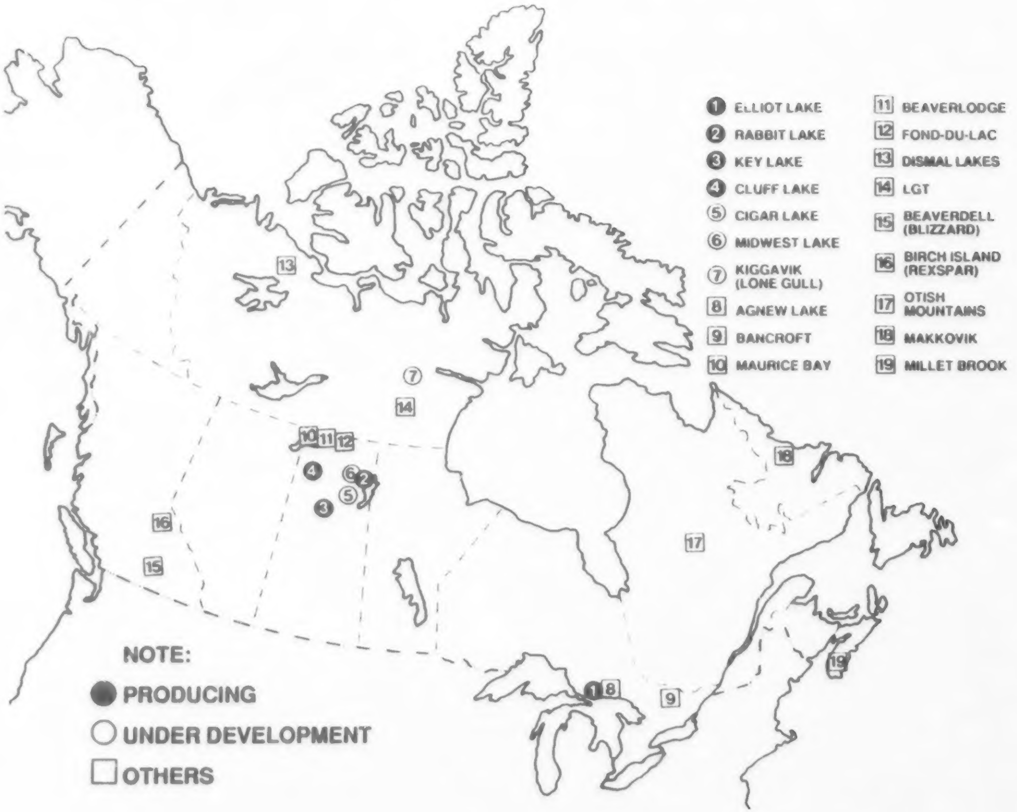


1988 PRIMARY PRODUCTION ≈ 12 400 TONNES U

SOURCE: UNEB/EMR

Figure 2

URANIUM DEPOSITS IN CANADA

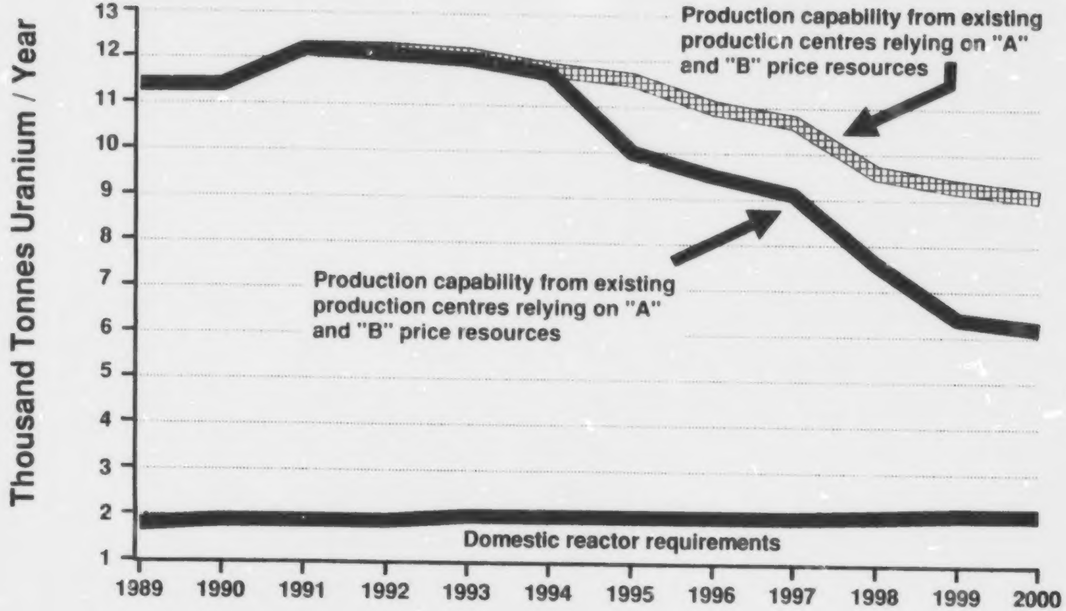


❶ ELLIOT LAKE
❷ RABBIT LAKE
❸ KEY LAKE
❹ CLUFF LAKE
⑤ CIGAR LAKE
⑥ MIDWEST LAKE
⑦ KIGGAVIK (LONE GULL)
8 AGNEW LAKE
9 BANCROFT
10 MAURICE BAY
11 BEAVERLODGE
12 FOND-DU-LAC
13 DISMAL LAKES
14 LGT
15 BEAVERDELL (BLIZZARD)
16 BIRCH ISLAND (REXSPAR)
17 OTISH MOUNTAINS
18 MAKKOVIK
19 MILLET BROOK
NOTE:
● PRODUCING
○ UNDER DEVELOPMENT
☐ OTHERS

SOURCE: UNEB/EMR

Figure 3

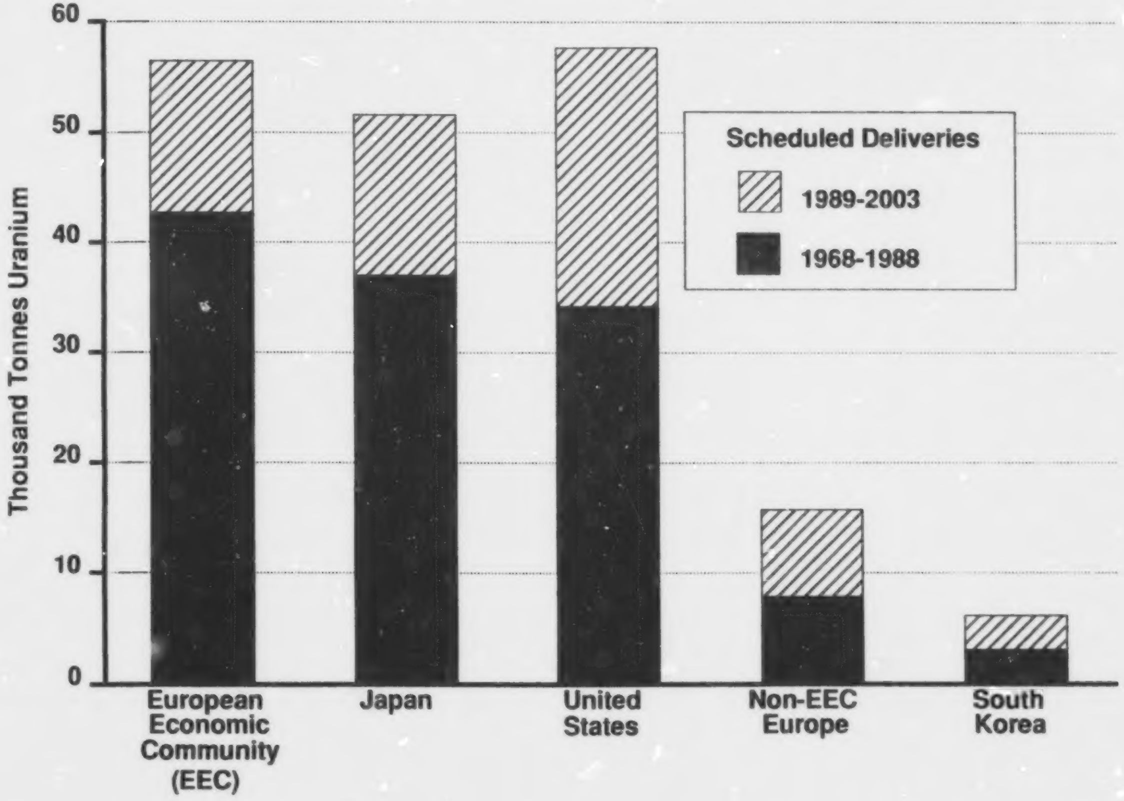
CANADIAN URANIUM PRODUCTION CAPABILITY COMPARED WITH DOMESTIC REACTOR REQUIREMENTS



SOURCE: UNEB/EMR

Figure 4

SCHEDULED DELIVERIES OF CANADIAN URANIUM FOR THE EXPORT MARKET



SOURCE: UNEB/EMR

Zinc

1989

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Zinc had another notable year during 1989 with strong market fundamentals and speculative activities on terminal markets supporting prices at their highest levels of the decade. The average annual zinc price on the London Metal Exchange (LME) was US¢77.7/lb., up from 56.3¢ in 1988 and 36.2¢ in 1987.

Western world zinc consumption declined marginally in 1989 reflecting weakening auto and construction sectors in North America and reduced global economic growth. High-capacity utilization was achieved for the second consecutive year, but strikes and equipment failures contributed to marginally reduce total metal production in 1989. Mine production also declined by about one percent, reflecting reduced output in Canada and Sweden.

Zinc metal stocks remained at an historic low in the first half of 1989, but jumped in August and again in late December. Overall, metal stocks represented the equivalent of six weeks of western world consumption by year-end, up from five weeks at the beginning of the year. Zinc prices moved up sharply during the first quarter of 1989, reflecting relative scarcity and speculative activities. Zinc prices remained fairly stable at around 75¢/lb. until the fall, albeit with a short-lived spike in August, and closed the year at 60¢.

The outlook for 1990 is for metal capacity to be constrained by concentrate shortfalls and for zinc consumption to decline slightly. In this context, zinc prices are likely to show strong variations in the first half and to resume a declining trend during the second half Zinc prices are likely to fall within a wide range of US¢45-75/lb. on the LME in 1990.

CANADIAN DEVELOPMENTS

Canadian mine output declined by 149 000 t in 1989 to about 1 198 000 t due to technical difficulties at several operations and natural events such as intense cold and forest fires. Nevertheless, Canada remains by far the world's largest producer of zinc concentrates with about 23.5% of western world supply. In 1989, two new mines opened, two mines re-opened and one mine expanded its capacity. It is expected that in 1990 mine production will increase with the return to normal production at existing mines and full production at the new mines.

Canadian metal production reached 670 000 t, down from 703 000 t in 1988. Preliminary estimates of metal consumption show a slight decline from 151 000 t in 1988. Details on ore grades, capacities and volume of concentrates produced in 1988 from Canadian zinc mines are listed in the table, "Principal Canadian Nonferrous and Precious Metal Mine Production," following the last commodity chapter of the Yearbook.

British Columbia

Cominco Ltd. completed an 18 000 t capacity expansion of its smelter in Trail, British Columbia, but also announced that it will not proceed with another expansion phase which would have brought its total capacity to 363 000 t/y in the early 1990s. The company explained that changes to the provincial water licence fee made additional investments uneconomical. Cominco's rated capacity is now 290 000 t/y.

The Trail smelter is fed with concentrates from Cominco's nearby Sullivan mine which experienced some technical difficulties, from the Polaris mine in the Northwest Territories, from the run-down of inventories accumulated at the Pine Point mine in the Northwest Territories before its closure in 1988, and from independent small mining operations. In 1990, Trail will also begin to receive concentrates from the large, new Red Dog operation in Alaska. Mining began in November but delays and technical difficulties have already reduced the volume available for shipments during the 1990 shipping season.

In July, Minnova Inc. opened the Samatosum silver zinc-copper mine near Barriere in southern British Columbia. Production will be from open pit for two to three years before going underground. Diluted reserves were reported at 766 000 t grading 833 g/t silver, 3.0% zinc, 1.6 g/t gold, 1.1% copper and 1.4% lead. The zinc concentrates are trucked to Cominco in Trail and the copper-silver concentrates are shipped overseas.

Curragh Resources Inc. plans to begin production at the large Cirque property north of Mackenzie in northern British Columbia in 1992. Reserves are estimated at 30 Mt grading 8.6% zinc and 3.5% lead. Development costs are estimated at about $130 million.

At the Eskay Creek project in northwestern British Columbia, Calpine Resources Incorporated released promising additional drilling results indicating reserves containing a significant percentage of zinc.

Regional Resources Ltd., a subsidiary of Mineral Resources International Limited, plans further underground exploration on the Midway deposit in northern British Columbia. Current geological reserves stand at 1.18 Mt grading 9.6% zinc, 7% lead and 410 g/t silver.

Bethlehem Resources Corporation purchased the former Goldstream copper-zinc mine near Revelstoke from Noranda Inc. Noranda mined mainly from an open pit for about a year before closing in April 1984 due to separation problems of the complex ore. Bethlehem plans to focus exclusively on the underground reserves. Current reserves stand at 1.86 Mt grading 4.81% copper and 3.01% zinc. About three months will be required to begin commercial production once appropriate financing has been completed.

Yukon

Curragh Resources Inc. declared force majeure on shipments from its Faro mine in January due to transportation problems caused by a combination of avalanches and cold weather. In July, forest fires caused production and transport problems and force majeure was in effect from July 24-28. Development work is proceeding on the nearby Grum and Vangorda deposits. These mines will be gradually phased in to offset declining Faro production.

Curragh bought from Banco Espanol de Credito a 20% equity interest in the Spanish zinc smelting company Asturiana de Zinc S.A. for $120 million. In return, Asturiana bought a 5% interest in Curragh and a 15% interest in the Cirque mine. The deal also provides for long-term supply commitments and joint marketing efforts in Europe.

Curragh and affiliated Hillsborough Resources Limited purchased the Mt. Hundere property near Watson Lake from Canamax Resources Inc. A $6 million exploration program was planned for the year. Curragh plans to bring the property into operation by 1992 at a rate of 90 000 t/y zinc in concentrates. Outlined reserves stand at 5.2 Mt grading 18.5% combined lead-zinc and 54.4 g/t silver.

Saskatchewan

Cameco - A Canadian Mining & Energy Corporation proceeded with additional drilling on its Hanson Lake property in northeastern Saskatchewan. Reserves are estimated at 7.8 Mt grading 6.4% zinc, 1.1% copper, 25 g/t silver and 0.6 g/t gold.

Manitoba

Hudson Bay Mining and Smelting Co., Limited (HBMS) opened the Callinan zinc-copper mine. The 15 000-18 000 t/y zinc in concentrate will replace declining mine output in the Flin Flon area. HBMS also completed an expansion program at the Chisel Lake mine. Operations at HBMS's Snow Lake and Ruttan mines were suspended for several days in July because of intense forest fires in northern Manitoba.

HBMS has proposed to upgrade its outmoded metallurgical complex at Flin Flon with an investment of over $130 million. The modernization would reduce operating costs and allow the company to meet Manitoba's stiffer SO_2 emission standards which will come into effect in 1994. HBMS has requested government assistance under the Acid Rain Abatement Program.

Ontario

Noranda increased its equity interest in Falconbridge Limited to 50% and Trelleborg AB of Sweden bought the other 50%. Together they outbid AMAX Inc. for the company. Falconbridge's worldwide operations are managed as a separate entity from the two owners.

Quebec

Aur Resources Inc. has released preliminary geological reserves information on the Louvicourt copper-zinc-gold discovery near Val-d'Or in northwestern Quebec. Results indicated 36 Mt averaging 3.11% copper, 1.34% zinc, plus silver and gold. The Louvicourt property is being explored in a joint venture with Louvem Mines Inc. Noranda Inc. owns 17% of Louvem and sought an injunction to stop Aur Resources from proceeding with underground exploration of the property.

Noranda continued a $125 million modernization program at its Valleyfield zinc smelter where it is building a new cellhouse and making various other improvements. Valleyfield operations encountered some technical difficulties which reduced its annual production. Brunswick Mining and Smelting Corporation Limited, a subsidiary of Noranda located at Belledune, New Brunswick, is considering the addition of a zinc roaster with the calcine to be refined at Valleyfield.

Audrey Resources Inc. significantly increased ore reserves when it outlined the 1100 lens of the Mobrun mine near Rouyn-Noranda in northwestern Quebec. An underground drilling program revealed 10.4 Mt grading 5.43% zinc, 0.76% copper, 37.4 g/t silver and 1.35 g/t gold. The 1100 lens is expected to be in production by 1992 at a development cost of about $50-60 million. Additional drilling is planned in 1990 from underground and surface.

Esso Minerals Canada sold its 35% equity interest in Les Mines Selbaie near Matagami in northwestern Quebec to Billiton Metals Canada Inc., a subsidiary of Billiton International Metals B.V. of the Netherlands. The zinc-copper mine is operated by BP Resources Canada Limited.

Bonanza Métals Inc. undertook a drilling program at the former Poirier mine near Joutel in northwestern Quebec with interesting results. Work began on a ramp to access a high-grade section and production is planned for 1990 in that section. Further exploration is planned in 1990. The Poirier mine was closed in 1975 by Rio Algom Limited.

In July, Minnova Inc. opened the Ansil mine near Rouyn-Noranda. It contains reserves estimated at 1.59 Mt grading 7.22% copper, 0.94% zinc, 26.4 g/t silver and 1.59 g/t gold. The ore is treated at the rehabilitated Norbec mill. The small zinc tonnage will be shipped to Valleyfield for smelting.

VSM Exploration Inc., controlled by Placer Dome Inc., released information on its drilling program at the Grevet property near Lebel-sur-Quevillon in northwestern Quebec. Probable reserves are estimated at 1.8 Mt grading 8.5% zinc, 0.46% copper, 0.18% lead and 37.3 g/t silver.

Deak Resources Corporation has assembled a gold and zinc mineral inventory of four properties in the Rouyn-Noranda region of Quebec and planned to acquire the bankrupt Golden Shield Resources Ltd.'s Kerr mine in northeastern Ontario. Deak plans to rehabilitate three circuits of the Kerr mill to process ore from the four deposits. The plan calls for dewatering the former open-pit West MacDonald zinc-gold-silver mine and bringing it into production shortly. The Hebecourt and Magusi deposits will also be brought into operation in the near future. Further exploration will be carried out on the Aldermac property. Total reserves from those deposits stand at 8.4 Mt grading 3.51% zinc, 1.21% copper, 0.62 g/t gold and 23.6 g/t silver.

New Brunswick

Operations at the recently opened Caribou mine near Bathurst were suspended in August due to a lack of financing for required development work to maintain sufficient mill feed. East-West Minerals NL invested about $45 million to open the mine, but further funds are needed to reopen it early in 1990. Milling operations are to begin sometime after sufficient feed is developed.

In September, Noranda and its associate, Brunswick Mining and Smelting, reactivated the Heath Steele mine near Bathurst, where operations were suspended in 1983 because of depressed prices. Operations are targeted on three ore bodies containing 4 Mt grading 6.3% zinc, 2.5% lead, 0.7% copper and 70 g/t silver. The mill operates at a rate of 2200 t/d.

Nova Scotia

Westminer Canada Limited, a subsidiary of Western Mining Corporation Holdings Limited of Australia, dewatered the Gays River mine near Halifax and test mining was carried out. Mining operations were suspended in August 1982 due to grade and hydrological problems. Proven and probable reserves are estimated at 4.7 Mt grading 4.2% zinc and 2.8% lead. Production is set to begin in January 1990 at a rate of 1350 t/d.

Newfoundland

Noranda Inc. and BP Resources Canada Limited continued exploration at their Tally Pond-Duck Pond joint venture. Drilling has shown reserves of 4 Mt with interesting grades of copper, zinc, lead, gold and silver.

The Newfoundland Zinc mine near Daniel's Harbour is expected to cease operation in mid-1990 due to ore exhaustion. Recent exploration efforts led to the discovery of small reserves which are insufficient to extend the life of the mine beyond mid-1990.

CANADIAN RESERVES

Canada is the world's largest producer of zinc. Mine production peaked in 1987 at 1 480 000 t metal content. Notwithstanding the opening of several new mines in 1988-89 and the prospect of additional mines opening in the 1990-92 period, total production is expected to fall rapidly after 1994 because of gradual ore reserve depletion at the larger mines. To maintain production after 1994, major new zinc ore discoveries are required in the immediate future given the long lead time necessary to turn discoveries into mines.

The 1980s saw a concentration of exploration efforts on gold and a general neglect of other base metals including zinc. This has been attributable to a number of factors including the severe recession of 1981-82 and the low base-metal prices which prevailed for several years. As a result, discoveries of zinc reserves during the 1981-85 period were only one quarter of those in the 1976-81 period. Recent improvements in zinc market fundamentals have already stimulate exploration activities and bear well for the immediate future.

WORLD DEVELOPMENTS

Western world mine production declined by about 1% in 1989. The strongest reduction in mine production occurred in Canada and Sweden. Mine output in Peru was far better than anticipated. Partly offsetting losses in other countries, mine output rose in the United States and Australia.

Europe

Mine output in Europe represented about 20% of western world production in 1989. The largest producers are Spain, Sweden and Ireland, all of which encountered some loss of production over 1988 levels. A 12-day strike by underground crusher operators at Outokumpu Oy's Tara mine in Ireland slightly reduced annual production. In Sweden, Boliden Mineral AB closed the 11 000 t/y Udden zinc mine. In Finland, Outokumpu Oy closed the Keretti mine due to exhaustion of ore. The mine had been in operation for 80 years.

Australia

Australian mine output has been increasing in the last four years, and its share of western world mine production rose from 13.5% to 15.5% between 1986 and 1989.

Aberfoyle Limited started up its new 1 Mt/y mill at the Hellyer mine in Tasmania. Mining operations had been expanded to feed the new mill. The Hellyer mine has reserves estimated at 16.2 Mt grading 13% zinc, 6.8% lead, 0.3% copper, 160 g/t silver and 2.3 g/t gold. Output from Hellyer will more than offset the decline in production from the nearby Que River mine, which is expected to close in 1991 because of ore exhaustion.

In July, M.I.M. Holdings Limited began commercial production at its Hilton mine in Queensland. Milling is set to begin in early 1990. Production from the integrated Hilton mine and Mt. Isa mine is expected to reach 250 000 t zinc in concentrates in 1989, up from 200 000 t in 1988.

Peru

Peru produces about 10% of western world zinc mine production. In 1989, mine output increased significantly notwithstanding continuing difficult labour relations, interruption of power supplies and a shortage of foreign exchange necessary to buy essential spare parts and equipment. Union members did not participate as militantly as before in national strike calls by unions and, as a result, output was about 20% higher than in 1988.

Cia. Minera San Ignacio de Morococha, S.A. began an expansion program which is set to double the current capacity of 33 000 t at the San Vicente mine. Cia. Minera Raura, S.A. has also expanded its zinc capacity by 2000 t from 25 000 t.

United States

The United States produces about 5% of western world zinc mine production, but its share will more than double after 1990 when the Red Dog mine will achieve full production. Also, six small-to-medium-size mines opened or re-opened in 1989.

Mining operations at Cominco's Red Dog mine, located 200 km north of the Arctic Circle in Alaska, began in August and milling began in November. Reserves total 77 Mt grading 17.1% zinc, 5.0% lead and 82 g/t silver. Operations are set to reach full production in 1992 with a mining rate of 5400 t/d. Despite its isolation, harsh climate and short shipping season, the mine is anticipated to be among the lowest-cost zinc operations due to its large orebody and high grade. First concentrate shipments are due during the summer of 1990.

The opening of Red Dog has been planned to compensate for the run-down of stocks from the closed Pine Point mine in the Northwest Territories and to ensure a constant concentrate supply to Cominco's zinc smelter in Trail, British Columbia. However, start-up problems have reduced the anticipated output available for shipment during 1990 by an unknown amount.

In February, Greens Creek Mining Co. opened the new Greens Creek mine on Admiralty Island in Alaska. Zinc mine capacity is set at 30 000 t/y. In April, New Butte Mining opened the Butte Hill mine in Montana. Zinc mine capacity is set at 20 000 t/y. In November, Silver King Mines Inc. opened the Ward Mountain mine in Ely, Nevada. Zinc mine capacity is set at 13 000 t/y. The Star-Phoenix Mining Company re-opened the Star Morning mine in Idaho which had been closed in 1982. The Doe Run Company re-opened the Brushy Creek mine in Bunker, Missouri, which had been closed in 1985. Finally, Cyprus Mining Company & St. Cloud Mining Co. began zinc production from the existing Pinos Altos copper mine in New Mexico.

Japan

Mine output continued a declining trend which began in 1985. Since then, mine production has declined by more than 100 000 t/y due to ore reserve exhaustion at several small mines. Nippon Mining Company Limited plans to develop the Jozankei deposit in the Hokkaido prefecture in the next four years. Ore reserves are estimated at 3 Mt grading 15% zinc, 13% lead and 260 g/t silver.

South Africa

The Prieska mine closed in September but treatment of low-grade dumps is set to continue for an indefinite period.

SMELTING

Western world refined zinc production declined by less than one per cent in 1989 due to supply disruptions and concentrate shortfalls. Production declined slightly in all regions of the world but primarily in Canada, Europe and Japan. Output increased in the United States and the Republic of Korea. Smelting capacity increased only slightly. Western world refined zinc production is 41% in Europe, 29% in the Americas, 20% in the Asian countries and 10% elsewhere.

Europe

In Finland, two short strikes in January and February at Outokumpu Oy's electrolytic plant in Kokkola temporarily reduced production. In Italy, labour unrest at Pertusola Sud SpA's zinc smelter in Crotone disrupted production several times during the first half of the year. In the United Kingdom, the Avonmouth zinc smelter was halted for three weeks in July and August because of a slag breakout. In Belgium, a short strike at the Overpelt zinc smelter caused a minor production loss. In Spain, Asturiana declared force majeure in June because of equipment failures.

In the Federal Republic of Germany (FRG), Preussag AG, in 1988, announced the permanent closure of its 70 000 t/y Harlingerode smelter. However, because of favourable market conditions, it kept operating 20 000 t of capacity to produce zinc oxide and dust. In June, Metallgesellschaft AG and M.I.M. Holdings Limited announced that they will expand capacity at the Ruhr Zink smelter from 140 000 t/y to 200 000 t/y by installing a pressure leaching facility. Construction should begin in 1990.

In Spain, Asturiana de Zinc S.A. announced that it will expand its capacity by 100 000 t to 320 000 t/y. The expansion is made possible by its association with Curragh Resources Inc., which will supply the additional concentrate requirements on a long-term contract basis.

Peru

Political and economic conditions are plagued by four-digit inflation and by deficient social institutions. The country also lacks the foreign exchange to purchase replacement parts and equipment. Consequent claims for higher wages and better working conditions led to strikes and production disruptions. In 1989, Peru's two zinc smelters were more adversely affected by domestic problems than in the past as combined output at the Cajamarquilla and La Oroya smelters was even lower than in 1988.

Elsewhere

In early 1989, Japanese smelters announced that they were reducing production by 10% for the first quarter to support negotiations for higher treatment charges for their smelting services. The cut-back did not help to alleviate an already tight metal supply. In the United States, Zinc Corporation of America announced that it will expand two stages its smelter capacity by 35 000 t in Pennsylvania. In Brazil, two 15 000 t expansion projects are being considered for completion in 1991.

Corporate Structure

The corporate structure of the European and other smelter industry has changed significantly in recent years, resulting in fewer but larger worldwide entities. Société Générale de Belgique (SGB) increased its equity in Vieille-Montagne SA in 1988 to 90% from 52%. SGB acquired another 6% in 1989. It also reorganized its nonferrous metals interests by reducing the role of its intermediate holding company, Union Minière SA. SGB also plans to purchase the remaining 24.7% share in Metallurgie Hoboken-Overpelt SA that it does not currently own and to acquire the remaining 4% share in Vieille-Montagne SA.

Trelleborg AB of Sweden and Noranda Inc. each purchased 50% of Falconbridge Limited. Trelleborg's acquisition follows its purchase of Boliden AB, the Swedish nonferrous company, in 1987. Earlier in 1989, Trelleborg, through its subsidiary Boliden International Mining AB, acquired a 10% interest in the Portuguese state-controlled nonferrous company, Pirites Alentejans, SARL.

RTZ Corporation PLC, with worldwide mining and smelting interests, purchased most of the multibillion dollar assets of BP Minerals International Limited in early 1989. The deal excluded BP Canada Inc. Shortly after the deal, RTZ sold its 4.5% equity entitlement in Pasminco Ltd. to a consortium of Japanese companies led by Mitsui Mining & Smelting Co. Ltd. RTZ has an indirect stake in Pasminco through its holdings in CRA Limited of Australia, which owns 40%.

Metallgesellschaft AG of the Federal Republic of West Germany increased its share in the Australian mining group, M.I.M. Holdings Limited, from 4% to 10.5%. M.I.M. owns a 3% interest in Metallgesellschaft and a 50% interest in Metallgesellschaft's Ruhr-Zink electrolytic plant. Metallgesellschaft and M.I.M. also own 25% each of Nunachiaq Inc., which has a 40% controlling interest in Cominco Ltd. Teck Corporation owns the other 50% of Nunachiaq.

In Australia, North Broken Hill Holdings Ltd. and CRA Limited merged their worldwide lead and zinc operations into one company renamed Pasminco Ltd., in 1988. The companies were already partners through The Broken Hill Associated Smelters Pty. Ltd.

Preussag AG of Germany and Société minière et métallurgique de Penarroya S.A. (Penarroya) of France agreed in 1988 to merge their zinc, lead and high-purity metals operations into a newly formed group called Metaleurop S.A. The venture does not include Preussag's existing mining operations or Penarroya's Crotone smelter. The new entity controls about 300 000 t/y of zinc smelting capacity.

CONSUMPTION AND USES

Western world zinc consumption remained at the record level achieved in 1988, reflecting various factors including a slowdown in global economic growth, lower activity in North American car and construction industries and substitution effects resulting from higher zinc prices. This stabilization of demand came after a buoyant year in 1988 in which metal consumption increased by a strong 5%. Notwithstanding the relatively high zinc prices, zinc remains the most cost-effective means of protecting steel against corrosion. Use of zinc in galvanizing is growing and many steel plants around the world have invested in, or plan to invest in, additional steel galvanizing lines.

There was a noticeable change in the distribution of western world consumption of refined zinc between 1975 and 1989. In 1975, consumption in developing countries accounted for about 15% of the total, whereas it now accounts for about 24%. During that period, over 40% of the total growth in zinc consumption occurred in developing countries. Consumption tripled in the Asian region and doubled in Central and South America, but remained virtually stable in the African region, excluding South Africa.

Prospects are for continued growth in galvanizing applications and for faster growth of zinc consumption in developing countries than in developed states.

Zinc is widely used, based on: its low melting point which facilitates shaping by casting; its high electrochemical activity which provides cathodic corrosion and contact protection (galvanizing) for iron and steel products; and its ability to alloy readily with copper to make brass. About 40% of zinc is used in galvanizing. The automotive industry is the largest consumer of galvanized steel. Corrosion is a major concern of car buyers, and manufacturers have responded by increasing the use of electrogalvanizing for exposed painted parts requiring high surface quality, and of hot-dipped galvanizing for unpainted parts.

Galvanized products such as structural components, roofing, siding and reinforcing bars are used in construction. Zinc and zinc-aluminum thermally sprayed coatings are utilized for long-term corrosion protection of large steel structures. The world's largest on-site, thermally sprayed structure is the Pierre Laporte bridge spanning the St. Lawrence River at Quebec City. Brass and bronze, as used in plumbing fittings, heating and air conditioning components and other products, account for about 20% of zinc consumption, as does the die-casting industry for products such as builders' hardware and fittings on automobiles. The balance is used for such items as zinc semi-manufactures, oxides, chemicals and dust. Zinc oxide is an important component in the manufacture of tires and rubber products.

Galfan, an improved galvanizing alloy developed by the International Lead and Zinc Research Organization (ILZRO), was first used commercially in 1983 in Japan. The alloy contains about 90% zinc, 5% aluminum and a small but significant amount of rare earth metals. The new alloy outperforms conventional galvanizing and Galvalume in corrosion resistance and several other characteristics. Another advantage is that only minor modifications are necessary to adapt existing galvanizing lines compared with the major cost of converting a line for Galvalume. Galvalume (55% aluminum, 43.4% zinc and 1.6% silicon) was developed by Bethlehem Steel Corporation and introduced into the U.S. market in 1976 for specialized applications. These alloys are complementary to galvanizing and increase the potential market for zinc.

INTERNATIONAL LEAD AND ZINC STUDY GROUP

The International Lead and Zinc Study Group was formed in 1959 to improve market information and to provide opportunities for regular intergovernmental consultations on lead and zinc markets. Particular attention is given to providing regular and frequent information on supply and demand and its probable development. Its 30th anniversary was celebrated in 1989.

The Study Group is headquartered in London, England. Its membership includes most major lead and zinc producing and consuming countries. While it has an extensive information-gathering and dissemination role, the Group has no market intervention powers. It holds a general session each year in the fall. Member countries' delegations generally include industry representatives as advisors. It is noteworthy that China joined the organization in 1987, as did the Republic of Korea. Canada has been an active member since its inception, and chaired the Group in 1988 and 1989.

PRICES AND STOCKS

In 1989, average zinc prices were high for a second consecutive year and reached US¢77.7/lb. on average, more than twice the 1987 average of 36.2¢.

Zinc prices on the London Metal Exchange (LME) began the year around US¢64 /lb. and closed at 60.7¢, the year's minimum. Continuing strong consumption growth in the first half of the year, depleted stocks and concerns about the short-term availability of concentrates pushed zinc prices to the year's peak of 96.6¢ in February. Thereafter, more realistic views on supply-demand fundamentals contributed to stabilize prices around the 75¢ level until the end of October. By year-end, increased metal stocks and negative economic news contributed to reduce prices to US¢60.7/lb.

The LME introduced a new futures contract for Special High Grade (SHG) zinc with a minimum purity of 99.995% in September 1988, and cash transactions began in December 1988. The new grade reflects technological changes in the use of zinc and growing demand by users for higher-purity metal.

The introduction of the new SHG contracts could not have come at a more volatile time as stocks were at their lowest levels in the decade and zinc was in tight supply. These factors stimulated speculative transactions and pushed prices to 96.6¢ on the LME market. Many zinc consumers were caught by surprise by the strength of the market and, in many cases, had to absorb the increased cost.

The introduction of SHG trading on the LME challenged the European Producer Price (EPP) as the basis for purchases of zinc concentrates and sales of zinc metal. The EPP, for Good Ordinary Brand (GOB) at 98.5% purity, was introduced by major zinc producers in 1964 to provide zinc users with more price stability. Most smelters decided to shift from the EPP to the SHG price effective January 1, 1989.

Total reported stocks of refined zinc metal remained fairly stable during the 1984-86 period, hovering around an equivalent of 6.5 weeks of western world consumption. Total stocks fell below the six-week level in 1987, and below five weeks in 1988 and the first half of 1989. Stocks jumped in August and again in December to finish the year with about six weeks of metal consumption. The upswing was attributable to reduced orders, which have also pushed up stocks held by producers.

HEALTH AND ENVIRONMENT

Every form of life, from micro-organisms to man, requires an adequate dietary amount of zinc. Man requires about 15 mg daily. Zinc deficiencies retard growth and could be a cause of abnormalities in humans. Zinc deficiency in soils has considerable economic implications in agriculture as zinc helps prevent diseases.

Zinc concentrates are transformed into zinc metal in metallurgical plants using either pyrometallurgical or hydrometallurgical processes. The hydrometallurgical (roast-leach-electrolysis) process has become the most important zinc recovery process because of lower unit operating costs, improved zinc recovery and greater amenability to environmental controls. The pyrometallurgical process involves zinc distillation in horizontal or vertical retort furnaces which are more labour-intensive and costly. In Canada, the four zinc smelters all use the roast-leach-electrolysis process and three of them recover a very high percentage of the sulphur content of feed in the form of sulphuric acid or elemental sulphur. The proposed modernization of the HBMS smelter at Flin Flon would virtually eliminate SO_2 emissions from the zinc circuit to meet Manitoba's SO_2 emission regulations for the plant.

OUTLOOK

Consumption of refined zinc is influenced by general economic trends and particularly the automotive and construction industries. Although, North American car production has been falling, more galvanized steel is being used to build each car because of the anti-corrosion properties of zinc-coated steel. In Europe and Japan, the prospects for car manufacturing are generally qualified as good. Construction activity is negatively influenced by the general level of indebtedness of both the private and commercial sectors, and also by high interest rates. Overall, western world zinc consumption should decline moderately in 1990.

In 1990, an increase in mine production is expected with expansions at several existing mines and new mines coming into commercial operation. However, the market will not be well supplied before the end of the summer when concentrates from arctic mines (Red Dog, Nanisivik and Polaris) arrive at smelters. In the meantime, shortfalls in zinc concentrate supplies may very well constrain metal production.

Zinc prices are expected to be volatile in 1990. During the first half, tight concentrate supply should constrain metal production and raise concerns about metal shortage. In the second half, the market should be well supplied and zinc prices should resume a downward trend. In this context, we expect zinc prices to hover within a range of US¢45-75/lb. on the LME in 1990.

Dollar-denominated zinc prices will also be influenced by the monetary policy of the U.S. Administration. Lower U.S. interest rates would tend to push down the U.S. dollar, thereby compounding the zinc price decreases denominated in other currencies.

In the longer term, zinc consumption in the western world is projected to grow at an annual average of 1.3% to the end of this century. While zinc in galvanizing is expected to grow faster, prospects for other zinc uses is not buoyant. Zinc in die-casting is expected to continue to decline because of competition from alternative materials.

In 1990, Canadian mining production should regain some of the losses recorded in the last two years with the return to normal production levels at many mines that have experienced technical difficulties in 1989 and with full production at mines opened in 1989. In the early 1990s, a number of new deposits are expected to be developed which should more than offset the declining output from existing mines due to ore exhaustion.

Note: *Information contained in this review was current as of mid-January 1990.*

TARIFFS

		Canada			United States	EEC	Japan[1]
Item No.	Description	MFN	GPT	USA	Canada	MFN	MFN
2603.00	Copper ores and concentrates						
2603.00.00.30	-----Zinc content	Free	Free	Free	Free	Free	Free
2607.00	Lead ores and concentrates						
2607.00.00.30	-----Zinc content	Free	Free	Free	1.5¢ kg on lead content	Free	Free
2608.00	Zinc ores and concentrates						
2608.00.00.30	-----Zinc content	Free	Free	Free	1.5¢ kg on lead content	Free	Free
2616.10	Silver ores and concentrates	Free	Free	Free	Free	Free	Free
2616.10.00.30	-----Zinc content	Free	Free	Free	Free	Free	Free
26.20	Ash and residues (other than from the manufacture of iron or steel), containing metals or metallic compounds						
	-Containing mainly zinc						
2620.11	--Hard zinc spelter	Free	Free	Free	1.3%	Free	Free
2817.00.00.10	-----Zinc oxide	10.5%	Free	8.4%	Free	11%	6.5%
2817.00.00.20	-----Zinc peroxide	10.5%	Free	8.4%	Free	11%	6.5%
28.33	Sulphates; alums; peroxosulphates (persulphates)						
2833.26	--Of zinc	9.2%	6%	5.5%	1.2%	9%	5.8%
79.01	Unwrought zinc						
	-Zinc, not alloyed						
7901.11	--Containing by weight 99.99% or more of zinc	Free	Free	Free	1.3%	3.5%	8 yen kg
7901.12	--Containing by weight less than 99.99% of zinc	Free	Free	Free	17.1%	3.5%	8 yen kg
7901.20	-Zinc alloys						
7901.20.10	--- Containing by weight 90% or more but less than 97.5% of zinc	Free	Free	Free	17.1%	3.5%	7.2–7.8 yen kg
7901.20.20	--- Containing by weight less than 90% of zinc	17.5%	11.5%	14.0%	17.1%	3.5%	7.2-7.8 yen kg

TARIFFS (cont'd)

Item No.	Description	Canada MFN	Canada GPT	Canada USA	United States Canada	EEC MFN	Japan[1] MFN
7902.00	Zinc waste and scrap	Free	Free	Free	Free	Free	1.9%
79.03	Zinc dust, powders and flakes						
7903.10	-Zinc dust	Free	Free	Free	0.6¢/kg	4.4%	5.8%
7903.90	-Other						
7903.90.10	---Powders, not alloyed	4%	Free	3.2%	0.6¢/kg	4.4%	5.8%
7903.90.20	---Alloyed powders; flakes	10.2%	6.5%	8.1%	8.5%	4.4%	5.8%
7904.00	Zinc bars, rods, profiles and wires						
7904.00.10	---Bars, rods or profiles, containing by weight 90% or more of zinc	Free	Free	Free	3.7%	8%	4.8%
7904.00.21	----Bars, rods or profiles; wire, coated or covered	10.2%	6.5%	8.1%	3.7%	8%	4.8%
7904.00.21.10	-----Bars and rods	10.2%	6.5%	8.1%	3.7%	8%	4.8%
7904.00.21.20	-----Profiles	10.2%	6.5%	8.1%	3.7%	8%	4.8%
7904.00.21.30	-----Wire	10.2%	6.5%	8.1%	3.7%	8%	4.8%
7904.00.22	----Wire, not coated or covered	8%	5%	6.4%	3.7%	8%	4.8%
7905.00	Zinc plates, sheets, strip and foil						
	---Containing by weight 90% or more of zinc						
7905.00.11	----Of a thickness exceeding 0.15 mm but less than 4.75 mm, for making offset printing plates; of a thickness exceeding 0.15 mm but less than 4.75 mm, not polished, coated on one side with acid-resisting material, imported for use by grinders and polishers, to be prepared for use in photo-engraving	Free	Free	Free	3.7%	8%	7.2%
7905.00.19	----Other	5.5%	3.5%	4.4%	3.7%	8%	7.2%
7905.00.20	---Containing by weight less than 90% of zinc	10.2%	6.5%	8.1%	3.7%	8%	7.2%

7906.00	Zinc tubes, pipes and tube or pipe fittings (for example, couplings, elbows, sleeves)	10.2%	6.5%	8.1%	3.4%	8%	4.8%
79.07	Other articles of zinc						
7907.10	-Gutters, roof capping, skylight frames and other fabricated building components	10.2%	6.5%	8.1%	5.1%	7%	4.9%
7907.90	-Other						
7907.90.10	---Anodes for electroplating	Free	Free	Free	3.0%	7%	5.8%
7907.90.20	---Discs or slugs, containing by weight 90% or more of zinc	5.5%	3.5%	4.4%	3.0%	7%	5.8%
7907.90.90	---Other	10.2%	6.5%	8.1%	5.1%	7%	5.8%
7907.90.90.11	------Not alloyed	10.2%	6.5%	8.1%	5.1%	7%	5.8%
7907.90.90.12	------Alloyed	10.2%	6.5%	8.1%	5.1%	7%	5.8%

Sources: Customs Tariff, effective January 1990, Revenue Canada, Customs and Excise; Harmonized Tariff Schedule of the United States (First Edition Supplement 2) effective January 1, 1989; Official Journal of the European Communities, Vol. 31, No. L298, 1988, "Conventional" column; Customs Tariff Schedules of Japan, 1989.

[1] GATT rate is shown; lower tariff rates may apply circumstantially.

Note: Where there is a tariff "range" a complete match of the HS code was not available; therefore, the high and low for the product in question is shown.

TABLE 1. CANADA, ZINC PRODUCTION AND TRADE, 1988 AND 1989, AND CONSUMPTION, 1986–88

	1988		1989p	
	(tonnes)	($000)	(tonnes)	($000)
Production				
All forms[1]				
Newfoundland	31 817	5 294	29 767	64 357
Nova Scotia	x	x	x	x
New Brunswick	261 089	431 581	224 616	485 620
Quebec	82 031	135 597	93 636	202 441
Ontario	326 698	540 032	257 456	578 239
Manitoba	53 746	88 843	72 518	156 785
Saskatchewan	x	x	x	x
British Columbia	142 833	236 102	130 658	282 483
Yukon	143 939	237 932	158 024	341 649
Northwest Territories	325 321	537 756	336 911	728 401
Total	1 370 000	2 264 611	1 315 274	2 843 622
Mine output[2]	1 347 424		1 198 181	
Refined[3]	703 206		670 333	
Exports			(Jan.–Sept.)	
Zinc content in zinc ores and concentrates				
Belgium	341 267	181 063	166 044	135 620
Japan	100 223	59 450	56 578	57 459
South Korea	79 811	49 081	48 661	50 667
West Germany	61 733	2 809	31 835	31 464
Netherlands	9 789	6 029	31 334	20 632
France	41 401	22 363	28 265	30 319
Italy	33 412	20 459	23 784	20 764
Other countries	147 100	85 015	59 819	61 102
Total	814 737	456 258	446 319	408 035
Zinc content in other ores and concentrates	2 148	1 273	6 020	7 757
Ash and residues containing hard zinc spelter				
United States	208	113	669	475
Korea, South	218	46	245	46
United Kingdom	95	29	93	42
France	94	35	75	29
India	37	5	34	17
South Africa	19	5	-	-
Total	671	234	1 116	611
Ash and residues containing mainly zinc, n.e.s.				
United States	4 672	2 653	5 226	3 313
United Kingdom	279	143	224	197
France	814	354	203	81
South Korea	119	121	164	225
India	724	480	149	72
Belgium	44	184	146	10
Other countries	1 194	692	292	357
Total	7 846	4 631	6 403	4 260

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989^{p}	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Zinc oxide; zinc peroxide				
United States	32 405	49 167	27 677	59 039
U.S.S.R.	1 591	2 482	2 567	4 228
Other countries	386	323	92	110
Total	34 382	51 974	30 336	63 379
Zinc sulphate	1	25	147	31
Zinc not alloyed unwrought containing by weight 99.99% or more of zinc				
United States	208 898	274 409	112 037	228 341
Japan	7 908	9 094	3 555	7 391
Taiwan	7 624	8 720	1 366	3 278
Argentina	366	441	1 339	2 623
Philippines	1 681	1 700	882	1 840
Singapore	2 217	2 536	549	1 268
Italy	-	-	523	867
Kenya	400	622	327	675
Portugal	-	-	299	534
Ecuador	1 109	1 188	237	485
Brazil	830	882	205	376
Other countries	38 333	40 357	883	1 883
Total	269 366	339 942	122 201	249 572
Zinc not alloyed unwrought containing by weight less than 99.99% of zinc				
United States	197 126	283 609	209 733	422 185
United Kingdom	13 119	20 682	11 011	21 901
Japan	11 357	15 615	10 425	21 695
New Zealand	-	-	7 161	11 989
Taiwan	13 394	16 827	6 334	13 584
Indonesia	5 715	7 383	4 514	8 766
Italy	3 853	5 383	3 457	7 047
Philippines	4 317	5 345	2 774	5 762
Israel	2 379	3 454	2 123	4 336
Singapore	2 937	3 972	2 087	4 203
Greece	1 234	1 556	1 336	2 522
Other countries	14 245	18 989	5 086	10 501
Total	269 677	382 830	266 040	534 502
Zinc alloys unwrought				
Hong Kong	1 742	2 579	2 040	4 049
Japan	124	142	1 118	2 475
Indonesia	-	-	1 088	2 566
Taiwan	743	938	958	2 298
United Kingdom	-	-	803	1 627
People's Republic of China	316	529	775	1 683
Malaysia	4	5	524	1 143
Philippines	185	205	470	1 158
United States	12 773	15 396	310	553
Other countries	1 856	2 039	270	664
Total	17 743	21 841	8 357	18 223

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989p	
	(tonnes)	($000)	(tonnes)	($000)
Exports (cont'd)				
Zinc waste and scrap				
United States	5 608	4 035	3 515	3 330
Taiwan	8 060	4 882	3 163	2 775
People's Republic of China	2 441	731	1 576	408
Other countries	813	619	748	373
Total	16 923	10 271	9 003	6 890
Zinc dust				
United States	4 766	8 875	3 884	9 893
Other countries	205	285	146	311
Total	4 971	9 163	4 030	10 206
Zinc powders and flakes				
Taiwan	-	-	25	35
United States	247	274	9	41
South Korea	3	24	5	52
France	19	10	3	17
Other countries	72	66	-	-
Total	341	377	42	147
Zinc bars, rods, profiles and wire				
Bolivia	-	-	231	171
Japan	-	-	20	6
United States	75	118	-	-
Finland	8	84	-	-
Total	83	203	251	177
Zinc plates, sheets, strip and foil				
United States	1 233	1 446	39	80
Other countries	18	3	2	11
Total	1 251	1 450	42	92
Zinc pipes or tubes and fittings				
United States	11	57	49	122
Other countries	6	27	9	51
Total	17	85	58	173
Articles of zinc, n.e.s.				
United States	1 670	5 622	1 602	2 488
Brazil	496	175	139	265
United Kingdom	8	30	55	91
People's Republic of China	1	2	51	13
Other countries	421	698	209	570
Total	2 597	6 538	2 057	3 398
Imports				
Zinc content in zinc ores and concentrates	34 538	24 695	23 183	23 327
Zinc content in copper ores and concentrates	49	84	251	549
Zinc content in lead ores and concentrates	1 830	2 646	2 625	4 701
Ash and residues containing mainly zinc, n.e.s.	108	132	173	99

TABLE 1. (cont'd)

	1988		Jan.-Sept. 1989p	
	(tonnes)	($000)	(tonnes)	($000)
Imports (cont'd)				
Zinc oxides: zinc peroxide	1 229	1 673	1 459	1 723
Zinc sulphate	2 494	1 547	2 026	1 171
Zinc not alloyed unwrought containing by weight 99.99% or more of zinc	1 552	2 093	601	1 259
Zinc not alloyed unwrought containing by weight less than 99.99% of zinc	733	1 188	392	844
Zinc alloys unwrought	5 742	9 831	2 744	6 080
Zinc waste and scrap	2 474	1 984	1 138	1 313
Zinc dust	674	1 059	500	1 088
Zinc powders and flakes	231	490	214	567
Zinc bars, rods, profiles and wire	1 097	1 953	623	1 600
Zinc plates, sheets, strip and foil	672	1 308	292	774
Zinc pipes or tubes and fittings	332	1 196	437	1 884
Articles of zinc, n.e.s.	2 555	9 120	1 855	7 542
Total	56 310	60 999	38 515	54 521

	1986			1987			1988p		
	Primary	Secondary[5]	Total	Primary	Secondary[5]	Total	Primary	Secondary[5]	Total
					(tonnes)				
Consumption[4]									
Zinc used for or in the production of									
Copper alloys (brass, bronze, etc.)	9 973	-	-	10 848	-	10 848	7 338	-	7 338
Galvanizing: electro	3 767	3 725	79 887	4 552	-	4 552	4 879	-	4 879
hot dip	62 422	-	-	65 060	x	x	73 315	x	x
Zinc die-cast alloy	12 297	x	x	15 265	x	x	22 564	x	x
Other products (including rolled and ribbon zinc, zinc oxides)	30 080	x	x	28 746	x	x	34 022	x	x
Total	118 539	7 576	126 115	124 471	7 188	131 659	142 118	8 987	151 105
Consumer stocks, year-end	11 437	423	11860	14 164	535	14 699	12 308	761	13 069

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [2] Zinc content of ores and concentrates produced. [3] Refined zinc produced from domestic and imported ores. [4] Consumer survey does not represent 100% of Canadian consumption and is therefore consistently less than apparent consumption.

p Preliminary; - Nil; x Confidential; n.e.s. Not elsewhere specified.

Note: Totals may not add due to rounding.

TABLE 2. CANADA, ZINC PRODUCTION, EXPORTS[1] AND DOMESTIC SHIPMENTS, 1970, 1975, 1980, 1983-89

	Production		Exports		
	All Forms[2]	Refined[3]	In Ores and Concentrates	Refined[3]	Total
			(tonnes)		
1970	1 135 714	417 906	809 248	318 834	1 128 082
1975	1 055 151	426 902	705 088	247 474	952 562
1980	883 697	591 565	434 178	471 949	906 127
1983	987 713	617 033	626 178	500 448	1 126 626
1984	1 062 701	689 841	539 633	529 659	1 069 292
1985	1 049 275	692 406	396 103	555 621[r]	951 724
1986	988 173	570 981	450 249[r]	427 176	877 425
1987	1 157 936	609 909[r]	613 185	441 227	1 054 412
1988	1 370 000	703 206	814 737	539 043	1 353 780
1989[p]	1 315 274	670 333	446 319[4]	388 242[4]	834 561[4]

Sources: Energy, Mines and Resources Canada; Statistics Canada.

[1] Beginning in 1988 exports are based on the new Harmonized System and may not be in complete accordance with previous method of reporting. Ores and concentrates include HS class 2608.00.30. Refined includes HS classes 7901.11 and 7901.12. [2] New refined zinc produced from domestic primary materials (concentrates, slags, residues, etc.) plus estimated recoverable zinc in ores and concentrates shipped for export. [3] Refined zinc produced from domestic and imported ores.

[4] Exports are January-September figures.

[p] Preliminary; [r] Revised.

Note: Totals may not add due to rounding.

TABLE 3. WESTERN WORLD, PRIMARY ZINC STATISTICS, 1985-89

	1985	1986	1987	1988	1989
			(000 tonnes)		
Mine Production (Zinc Content)	5 152	5 090	5 362	5 106	5 085
Metal Production	4 996	4 854	5 055	5 236	5 205
Metal Consumption	4 745	4 885	5 030	5 258	5 257

Source: International Lead and Zinc Study Group.

TABLE 4. WESTERN WORLD ZINC MINE PRODUCTION, 1987-89

	1987	1988	1989
		(000 tonnes)	
Europe			
Germany, Federal Republic of	99	75	64
Ireland	177	177	169
Spain	273	278	262
Sweden	219	193	153
Yugoslavia	71	71	73
Others	250	271	260
Total	1 089	1 065	981
Africa			
South Africa[1]	153	127	114
Zaire	87	91	90
Zambia	56	47	41
Others	29	31	32
Total	325	296	277
Oceania			
Australia	721	739	798
Americas			
Brazil	98	99	103
Canada	1 504	1 348	1 211
Mexico	271	271	271
Peru	612	485	597
United States	233	256	295
Others	108	134	165
Total	2 826	2 593	2 642
Asia			
Japan	166	147	131
Others	235	266	254
Total	401	413	385
Total Western World	5 362	5 106	5 083

Source: International Lead and Zinc Study Group.

[1] Includes Namibia.

TABLE 5. WESTERN WORLD ZINC METAL PRODUCTION, 1987-89

	1987	1988	1989
		(000 tonnes)	
Europe			
Belgium	284	298	287
Finland	152	156	162
France	249	274	266
Germany, Federal Republic of	378	352	348
Italy	247	242	248
Netherlands	205	210	203
Norway	117	122	121
Spain	224	256	249
United Kingdom	81	77	79
Yugoslavia	122	129	127
Others	30	31	31
Total	2 089	2 147	2 121
Africa			
South Africa[1]	96	85	85
Zaire	55	61	60
Others	40	58	44
Total	191	204	189
Americas			
Argentina	31	33	32
Brazil	139	139	158
Canada	610	703	669
Mexico	186	191	193
Peru	145	125	139
United States	343	330	361
Total	1 455	1 521	1 552
Asia			
Japan	666	678	664
Korea, Republic of	186	224	241
Others	156	160	163
Total	1 008	1 062	1 068
Oceania			
Australia	312	302	295
Total Western World	5 055	5 236	5 225

Source: International Lead and Zinc Study Group.

[1] Includes Namibia.

TABLE 6. WESTERN WORLD ZINC CONSUMPTION 1987-89

	1987	1988	1989
		(000 tonnes)	
Europe			
Belgium	163	175	185
France	253	290	294
Germany, Federal Republic of	452	446	447
Italy	245	250	240
Spain	110	127	129
United Kingdom	188	193	197
Yugoslavia	96	106	108
Others	224	244	255
Total	1 731	1 831	1 855
Africa			
South Africa[1]	84	88	86
Others	63	67	65
Total	147	155	151
Oceania			
Australia	82	90	99
New Zealand	12	18	18
Total	94	108	117
Americas			
Brazil	164	143	136
Canada	158	159	146
Mexico	110	116	107
United States	1 052	1 089	1 077
Others	157	162	153
Total	1 641	1 669	1 619
Asia			
India	130	142	144
Japan	729	774	774
Korea, Republic of	179	173	177
Others	369	406	422
Total	1 417	1 495	1 517
Total Western World	5 030	5 258	5 259

Source: International Lead and Zinc Study Group.

[1] Includes Namibia.

TABLE 7. CANADA, PRIMARY ZINC METAL CAPACITY, 1989

Company and Location	Annual Rated Capacity
	(000 tonnes of slab zinc)
Canadian Electrolytic Zinc Limited (CEZ) Valleyfield, Quebec	227
Falconbridge Limited Timmins, Ontario	133
Hudson Bay Mining and Smelting Co., Limited (HBMS) Flin Flon, Manitoba	85
Cominco Ltd. Trail, British Columbia	290
Canada Total	735

TABLE 8. MONTHLY AVERAGE ZINC PRICES (High-Grade Zinc), 1988 AND 1989

	American Producer (USc lb.)	Canadian Producer (Cc lb.)	LME Settlement (USc lb.)
1988			
January	44.4	59.0	39.9
February	45.4	59.0	39.7
March	47.9	60.8	44.2
April	51.5	65.0	48.4
May	56.0	69.2	53.4
June	62.6	76.1	62.1
July	65.6	77.5	56.1
August	66.5	77.5	59.4
September	68.3	84.5	60.3
October	69.5	85.0	68.9
November	72.0	86.5	70.6
December	75.0	89.5	72.3
Year Average	60.4	74.1	56.3
1989			
January	70.5	97.0	78.7
February	83.5	100.0	87.7
March	95.0	113.0	89.0
April	88.9	104.0	75.2
May	85.7	101.0	73.9
June	80.5	97.3	69.8
July	80.0	96.0	73.3
August	82.4	98.3	78.5
September	81.1	95.9	73.9
October	79.9	94.5	71.9
November	76.3	88.9	65.2
December	73.0	85.5	66.0
Year Average	81.5	97.6	75.2

Sources: Metals Week; ILZSG; Northern Miner.
Note: For 1989, Canadian producer prices are for special high grade.

Principal Canadian Nonferrous and Precious Metal Mine Production in 1988, with Highlights for 1989

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1988, WITH HIGHLIGHTS FOR 1989

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1989 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)			(percent)		(grams/tonne)		(tonnes)			(tonnes)		(kilograms)		
NEWFOUNDLAND															
Hope Brook Gold Inc. Hope Brook mine Couteau Bay	3 000	-	-	-	-	0.38	4.29	762 940	-	-	-	-	203	2 301	Underground mining began to replace open pit starting in 1988
Newfoundland Zinc Mines Limited Daniel's Harbour	1 450	-	-	-	7.35	-	-	450 000	-	-	-	32 680	-	-	Mine life extended through further ore discoveries.
NEW BRUNSWICK															
Brunswick Mining and Smelting Corporation Limited, No. 12 mine Bathurst	10 250	0.36	-	3.50	8.84	104.0	-	3 493 900	10 253	-	87 377	257 826	249 983	-	Technical problem reduced ore production in 1989.
East West Caribou Mining Limited Caribou mine Bathurst	2 000	-	-	3.04	7.18	84.99	-	37 530	-	-	240	932	464	-	Mine reopened in November 1988 and closed in August 1989. Decision to reopen in 1990 is pending.
Gordex Minerals Limited Cape Spencer	635	-	-	-	-	0.17	1.68	111 460	-	-	-	-	7	69	
Noranda Inc. Heath Steele and Stratmat mine Bathurst	2 200	-	-	-	-	-	-	-	-	-	-	-	-	-	Production resumed at Heath Steele underground mine and at Stratmat open pit in mid-1989.
QUEBEC															
Agnico-Eagle Mines Limited Joutel	1 630	-	-	-	-	1.71	6.55	316 086	-	-	-	-	529	1 878	
American Barrick Resources Corporation Camflo Division Val-d'Or	1 210	-	-	-	-	0.17	3.36	446 850	-	-	-	-	73	1 384	
Audrey Resources Inc. Mobrun mine Rouyn-Noranda	1 000	-	-	-	-	-	-	-	-	-	-	-	-	-	Mining resumed Sept. 1989 following completion of new mill
Aunzon Mines Ltd. Sleeping Giant mine	900	-	-	-	-	6.62	4.42	164 532	-	-	-	-	869	583	
Beacon mine Val-d'Or	750	-	-	-	-	0.65	3.61	96 370	-	-	-	-	40	311	Shaft deepened to 3350 ft level
Aur Resources Inc. Kierens mine Malartic	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Mine opened in mid 1989. Ore shipped to Dorval mill. Considering mill construction

Bachelor Lake Gold Mines Inc. Desmaraisville	450	-	-	-	-	0.58	5.01	130 906	-	-	-	-	72	623	Mine closed due to high operating costs.
Belmoral Mines Ltd. Ferderber mine Dumont mine Val-d'Or	1 360	-	-	-	-	0.96	7.82	195 407	-	-	-	-	175	1 406	
BP Resources Canada Limited Les Mines Selbaie A-1 open pit, B and A-2 underground mines Joutel	6 650	1.09	-	-	2.17	54.51	0.41	2 572 760	25 830	-	-	50 752	16 321	871	35% interest held by Esso Resources Canada Limited sold to Billiton Metals Canada Inc.
Cambior inc. Pierre Beauchemin mine Rouyn	1 020	-	-	-	-	1.37	4.25	370 652	-	-	-	-	455	1 386	Vezina mine closed late 1988 and Pierre Beauchemin mine opened.
Lucien E. Beliveau mine Val-d'Or	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Mine opened in September 1989, formerly the Pascalis project.
Campbell Resources Inc. Meston Lake Resources Inc. Joe Mann mine Chibougamau	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Sinking new shaft, to raise production to 1800 t/d by March 1991. Mill refurbished in 1989.
Campbell Resources Inc. Henderson I and II, Cedar Bay and S-3 mines, common mill	2 900	0.58	-	-	-	5.18	5.28	426 830	2 400	-	-	-	1 936	1 892	Mining at Henderson I and II mines suspended in 1988.
Dumagami Mines Limited La Ronde mine Cadillac	1 360	0.78	-	-	-	3.77	4.18	281 435	191	-	-	-	803	526	Copper-gold production began 1988, mainly open pit but expanding underground capacity.
Inco Gold Company Mines Casa Berardi La Sarre	1 200	-	-	-	-	1.40	5.75	123 990	-	-	-	-	115	473	Developing second mine.
LAC Minerals Ltd.- Société québécoise d'exploration minière (SOQUEM) Joint Venture Cadillac	3 125	-	-	-	-	0.55	6.24	1 097 965	-	-	-	-	560	6 298	
LAC Minerals Ltd. Est-Malartic Division Malartic	2 000	-	-	-	-	0.51	3.53	560 140	-	-	-	-	267	1 805	
Terrains Aurifères Division Cadillac	1 590	-	-	-	-	1.12	6.15	476 600	-	-	-	-	492	2 688	

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1988, WITH HIGHLIGHTS FOR 1989 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1989 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)			(percent)		(grams/tonne)		(tonnes)			(tonnes)		(kilograms)		
QUEBEC (cont'd)															
Minnova Inc.															
Lake Dufault Division Ansil mine Noranda	1 640	0.77	-	-	2.3	29.42	2.37	250 590	1 483	-	-	4 621	2 109	282	Production began mid-1989 following refurbishment of Norbec mill.
Lake Shortt Division Desmaraisville	1 150	-	-	-	-	1.10	4.66	371 380	-	-	-	-	42	1 598	
Opemiska Division Perry, Springer and Cooke mines Chapais	2 800	1.39	-	-	-	11.66	2.40	349 075	4 701	-	-	-	3 382	740	
Muscocho Explorations Ltd Montauban mine Montauban	400	-	-	-	-	10.72	3.33	119 170	-	-	-	-	752	356	
Placer Dome Inc.															
Sigma mine	1 290	-	-	-	-	0.62	4.83	416 660	-	-	-	-	244	1 932	
Kiena mine Val-d'Or	1 250	-	-	-	-	16.80	3.97	477 950	-	-	-	-	236	1 809	
Noranda Inc.															
Division Mines Gaspé E zone Murdochville	3 000	-	-	-	-	-	-	-	-	-	-	-	-	-	E zone resumed production early 1989. Also produces molybdenum.
Horne Division Rouyn-Noranda	3 450	-	-	-	-	9.94	4.11	102 920	374	-	-	-	513	329	
Mattagami Division Isle Dieu and Norita mines Matagami	3 175	1.02	-	-	5.18	21.19	0.27	681 740	5 908	-	-	32 423	5 500	37	Mattabi mine closed and Isle Dieu mine opened in 1988.
Louvem Mines Inc. Chimo mine Val-d'Or	800	-	-	-	-	0.66	4.73	140 706	-	-	-	-	90	631	Cambior Inc. acquired 50% interest in Chimo mine. Production was halted and further development and shaft expansions were completed in 1989.
Westminer Canada Limited Copper Rand and Portage mines Chibougamau	3 080	1.56	-	-	-	8.48	4.51	559 150	8 578	-	-	-	3 212	2 324	
ONTARIO															
Agnico-Eagle Mines Limited Silver Division Cobalt	245	-	-	-	-	800.23	-	57 950	-	-	-	-	44 068	-	Closed in 1989

American Barrick Resources Corporation Holt-McDermott mine Kirkland Lake	1 360	-	-	-	-	0.31	3.70	219 070	-	-	-	-	63	744	
Ateba Mines Inc. Thunder Bay	118	-	-	-	-	0.17	2.75	28 395	-	-	-	-	3	44	
Bond Gold Canada Inc. Pickle Lake	250	-	-	-	-	2.37	18.06	30 525	-	-	-	-	67	507	Control of Bond Gold Canada Inc. purchased by LAC Minerals Ltd. in 1989.
Canamax Resources Inc.															
Kremzar mine Wawa	550	-	-	-	-	0.29	3.87	52 710	-	-	-	-	13	173	
Bell Creek mine Timmins	350	-	-	-	-	0.51	6.69	122 760	-	-	-	-	80	767	
Citadel Gold Mines Inc. Surlaga mine Wawa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Unable to achieve suitable production.
Corona Corporation															
Renabie mine Wawa	595	-	-	-	-	1.20	6.51	203 100	-	-	-	-	219	1 203	
Williams mine Hemlo	6 000	-	-	-	-	1.09	8.11	1 541 630	-	-	-	-	1 089	11 787	Supreme Court of Canada awarded former Page-Williams mine to Corona Corporation and Teck Corporation from LAC Minerals Ltd. in 1989.
Dickenson Mines Limited Red Lake	907	-	-	-	-	1.37	10.63	235 150	-	-	-	-	282	2 197	
Emerald Lake Resources Inc.* Golden Rose mine Sturgeon Falls	400	-	-	-	-	-	7.2	-	-	-	-	-	-	-	Mine closed in 1988. * Name change to Noramco Mining Corporation in 1988.
Eastmaque Gold Mines Ltd. Kirkland Lake	2 040	-	-	-	-	0.65	1.37	426 520	-	-	-	-	201	428	
ERG Resources Inc. Timmins	40 000	-	-	-	-	0.47	0.53	565 850	-	-	-	-	82	92	Treats old tailings.
Falconbridge Limited															
Sudbury operations (7 mines) Falconbridge and Strathcona mills	11 790	1.19	1.45	-	-	5.34	0.14	2 591 150	29 114	32 768	-	-	11 679	297	Craig mine being developed to produce over 20 400 t/y of nickel by late 1993.
Timmins operations	13 500	2.94	-	0.16	5.83	71.37	-	4 300 975	121 741	-	5 260	221 801	251 938	-	Began 8-year program to maintain production as mining deepens.
Kidd Creek Gold Hoyle Pond mine Owl Creek mine	425	-	-	-	-	-	13.81	147 640	-	-	-	-	-	1 926	
Flanagan McAdam Resources Inc. Magnacon mine Hemlo area	-	-	-	-	-	-	-	-	-	-	-	-	-	-	600 t/d mine opened in 1989.

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1988, WITH HIGHLIGHTS FOR 1989 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1989 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)			(percent)		(grams/tonne)		(tonnes)			(tonnes)		(kilograms)		
ONTARIO (cont'd)															
Giant Yellowknife Mines Limited															
Pamour No. 1 mill	2 630	-	-	-	-	1.48	2.26	934 620	-	-	-	-	297	1 801	
Shumacher mill	2 586	0.06	0.01	0.01	0.04	2.78	2.67	734 920	181	-	-	-	857	1 753	
Golden Shield Resources Ltd. Kerr Addison mine Virginiatown	1 226	-	-	-	-	0.17	3.19	350 746	-	-	-	-	58	1 082	Operation closed for financial reasons in 1989.
Hemlo Gold Mines Inc. Golden Giant mine Marathon	3 000	-	-	-	-	1.47	11.84	927 100	-	-	-	-	337	10 498	
Inco Limited Sudbury and Shebandowan	56 245	1.15	1.21	-	-	5.90	0.38	10 610 390	115 658	108 459	-	-	48 610	2 689	Shebandowan mine reopened in 1989 and plans to develop McCreedy East mine by 1993.
LAC Minerals Ltd Macassa Division Kirkland Lake	450	-	-	-	-	2.26	14.95	170 610	-	-	-	-	366	2 437	
Lac d'Amiante du Québec, Ltée Aquarius mill	270	-	-	-	-	0.41	5.87	61 506	-	-	-	-	24	337	
Mattabi Mines Limited Lyon Lake mine Ignace	2 790	0.83	-	0.81	8.46	99.77	0.34	623 026	3 630	-	4 201	50 195	53 212	157	Mattabi mine closed Sept 1988.
Muscocho Explorations Ltd. Wawa	360	-	-	-	-	0.60	3.63	56 610	-	-	-	-	32	194	
Minnova Inc. Zenmac mine Winston Lake	1 000	0.86	-	-	16.60	31.17	0.82	220 326	1 384	-	-	33 459	1 873	74	Zinc-copper-gold mine and 1000 t/d mill opened in 1988 to achieve full production in 1989.
Noranda Inc. Geco Division Manitouwadge	3 810	1.77	-	0.23	4.70	56.23	0.14	1 309 800	21 615	-	1 844	58 312	57 174	98	Technical problems reduced ore production in 1989.
Orofino Resources Limited Scadding Twp.	93	-	-	-	-	-	5.07	33 990	-	-	-	-	-	147	
Placer Dome Inc.															
Campbell mine Red Lake	1 066	-	-	-	-	1.90	21.57	366 655	-	-	-	-	655	7 433	Opened Dona Lake mine in 1989.
Detour Lake mine N.E. Ontario	2 300	-	-	-	-	1.71	4.49	806 568	-	-	-	-	1 306	3 407	
Dome mine South Porcupine	3 130	-	-	-	-	0.55	3.46	1 026 750	-	-	-	-	546	3 410	

Queenston Gold Mines Limited McBean mine Kirkland Lake	590	-	-	-	-	0.52	3.66	39 088	-	-	-	-	19	131	
St. Andrew Goldfields Ltd. Stock Twp. mine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Completed underground development and mill in 1989.
Teck-Corona Corp. Joint Venture David Bell mine Hemlo	1 070	-	-	-	-	0.72	17.83	382 556	-	-	-	-	270	6 745	
Timmins Nickel Inc. Redstone mine Timmins	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Underground nickel mine opened in 1989; ore milled at Giant Yellowknife.
MANITOBA															
Granges Inc. Abermin Corporation Tartan Lake mine Flin Flon	400	-	-	-	-	0.37	7.41	95 200	-	-	-	-	19	381	Closed in 1989.
Hudson Bay Mining and Smelting Co., Limited (9 mines), Flin Flon and Snow Lake concentrators	10 520	2.38	-	0.11	3.70	16.03	1.49	1 583 880	38 230	-	1 212	53 537	18 946	1 759	Callinan mine opened late 1989 and Chisel Lake mine expanded.
Rutten mine Leaf Rapids	6 700	1.38	-	-	0.94	13.44	0.55	1 281 930	16 471	-	-	10 080	14 097	262	
Hudson Bay/Outokumpu Mines Ltd. Joint Venture Namew Lake mine Flin Flon	1 905	0.61	2.02	-	-	-	-	19 455	93	310	-	-	-	-	Mining difficulties reduced production from planned levels
Inco Limited Thompson underground and open-pit mines Thompson district	14 025	0.19	2.83	-	-	5.14	0.10	2 922 300	5 188	76 219	-	-	8 587	134	Production started at Birchtree mines and Thompson Open Pit South being developed.
LynnGold Resources Inc. MacLellan mine Lynn Lake	1 100	-	-	-	-	19.36	5.59	355 420	-	-	-	-	2 765	1 712	Mine closed in 1989.
Pioneer Metals Corporation Puffy Lake mine Sherridon	1 000	-	-	-	-	0.86	2.61	291 800	-	-	-	-	206	626	
SASKATCHEWAN															
Cameco - A Canadian Mining & Energy Corporation Star Lake mine La Ronge	200	-	-	-	-	1.68	14.67	76 680	-	-	-	-	94	1 048	Star Lake ore reserves exhausted end of 1988; mill operated into 1989.
Corona Corporation Jolu mine La Ronge	400	-	-	-	-	0.38	15.77	22 320	-	-	-	-	8	317	

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1988, WITH HIGHLIGHTS FOR 1989 (cont'd)

Company and Mine Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1989 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)			(percent)		(grams tonne)		(tonnes)			(tonnes)		(kilograms)		
BRITISH COLUMBIA															
Blackdome Mining Corporation Blackdome mine Williams Lake	180	-	-	-	-	101.49	21.60	79 396	-	-	-	-	5 777	1 602	
Brenda Mines Ltd Peachland	30 000	0.18	-	-	-	1.64	0.02	11 285 951	18 134	-	-	-	9 229	141	Mine scheduled to close about Sept. 1990 due to ore exhaustion. Also produces molybdenum.
Broken Hill Proprietary Company Limited, The Utah Division Island Copper mine Port Hardy	46 500	0.47	-	-	-	1.65	0.18	16 703 942	64 127	-	-	-	14 293	1 287	Extending pit wall to lengthen mine life to 1996. Also produces molybdenum and rhenium.
Cassiar Mining Corporation Similco mine Princeton	22 680	0.50	-	-	-	3.53	0.15	7 189 439	28 287	-	-	-	12 672	525	
Cheni Gold Mines Inc. Lawyers mine North Central, B.C.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Gold mine opened in August 1989 at 1 700 kg/y production.
Chevron Resources Company Homestake Mining Company Golden Bear mine	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Gold mine opened late 1989 plans 1 880 kg/y production.
Corona Corporation Nickel Plate mine Hedley	2 903	-	-	-	-	4.01	3.70	879 664	-	-	-	-	2 956	2 716	
Cominco Ltd. Sullivan mine Kimberley	9 070	-	-	5.60	5.60	51.43	-	2 038 172	-	-	104 067	102 087	92 167	-	
Dickenson Mines Limited Silvana Division Silmonac mine New Denver	115	-	-	6.16	7.6	480.0	-	27 578	-	-	1 613	1 919	12 867	-	
Gibraltar Mines Limited McLeese Lake	36 290	0.32	-	-	-	-	-	5 473 046	13 765	-	-	-	-	-	Stripping Pollyanna pit with some ore production; 29-week strike in 1988. Copper production excludes SX-EW (about 4500 t). Also produces molybdenum.
Highland Valley Copper (Partnership of Cominco-Rio Algom Limited-Teck Corporation) Logan Lake	120 000	0.47	-	-	-	2.91	0.03	44 108 229	174 687	-	-	-	64 235	416	Former Highmont mill moved to Lornex site. Bethlehem mill closed. Milling capacity raised to 131 000 t/d. Also produces molybdenum.

Minnova Inc. Samatosum mine Adams Lake	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Zinc-copper-lead-silver-gold mine opened in mid-1989.
Noranda Inc. Bell Copper mine Babine Lake	15 420	0.50	-	-	-	1.3	0.21	5 367 304	22 629	-	-	-	3 182	871	
Placer Dome Inc. Equity Silver mine Houston	9 000	0.31	-	-	-	93.26	0.86	3 227 763	7 116	-	-	-	202 799	1 536	
Skylark Resources Ltd. Greenwood	408	-	-	-	-	1011.09	3.77	21 591	-	-	-	-	8 836	51	
Skyline Gold Corporation Iskut River	300	0.48	-	-	-	33.02	16.90	23 476	89	-	-	-	601	308	Name changed from Skyline Explorations Ltd. in 1989. Mill modification undertaken in 1989 to improve recovery.
Sumac Ventures Inc. Grand Forks	270	-	-	-	-	17.14	0.96	12 701	-	-	-	-	159	9	
International Taurus Resources Inc. Cassiar area	160	-	-	-	-	1.37	3.77	3 991	-	-	-	-	3	8	
Teck Corporation Afton Operating Corporation Kamloops	7 700	0.32	-	-	-	-	1.37	3 111 329	6 769	-	-	-	1 368	491	Ajax open pit mine commenced early 1989, replacing Comet-Davenport pit.
Beaverdell mine Beaverdell	100	-	-	0.36	0.42	322.97	-	37 264	-	-	121	132	10 519	-	
TOTAL Energold Corporation Cassiar	270	-	-	-	-	9.98	7.68	71 892	-	-	-	-	609	521	Closed late 1988.
Westmin Resources Limited															
H-W, Lynx mines Buttle Lake	3 999	2.50	-	0.31	4.79	39.09	2.33	1 255 124	29 232	-	3 402	53 339	35 232	1 536	
Premier mine Stewart	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Production began in mid-1989.
YUKON TERRITORY															
Canamax Resources Inc. Ketza River	290	-	-	-	-	0.50	11.52	51 989	-	-	-	-	23	536	
Curragh Resources Inc. Faro mine	13 500	0.15	-	3.62	4.87	52.01	0.11	4 125 873	2 877	-	125 366	167 403	130 890	350	Developing Grum and Vangorda mines to replace Faro mine.
Total Erickson Resources Ltd. Mount Skukum mine	270	-	-	-	-	5.04	6.58	27 998	-	-	-	-	129	188	Closed 1988.
United Keno Hill Mines Limited Elsa, Husky, No Cash, Keno mines Elsa	450	-	-	4.31	-	589.14	-	91 898	-	-	-	2 978	53 832	-	Closed early 1989 due to low silver prices.

PRINCIPAL CANADIAN NONFERROUS AND PRECIOUS METAL MINE PRODUCTION IN 1988, WITH HIGHLIGHTS FOR 1989 (cont'd)

Company and Mine/Mill Location	Capacity	Grades of Ore Milled						Ore Milled	Metal Contained in All Concentrates Produced						1989 Highlights
		Cu	Ni	Pb	Zn	Ag	Au		Copper	Nickel	Lead	Zinc	Silver	Gold	
	(tonnes per day)			(percent)		(grams/tonne)		(tonnes)			(tonnes)		(kilograms)		
NORTHWEST TERRITORIES															
Cominco Ltd. Polaris mine Little Cornwallis Island	3 360	-	-	3.70	13.80	-	-	1 080 366	-	-	36 016	135 737	-	-	
Echo Bay Mines Ltd. Lupin mine Contwoyto Lake	1 680	-	-	-	-	1.68	10.58	626 280	-	-	-	-	982	6 297	
Giant Yellowknife Mines Limited Yellowknife Division															
Giant mine	1 130	-	-	-	-	2.06	7.30	329 121	-	-	-	-	474	2 017	
Giant mill-tailings operations Yellowknife	9 070	-	-	-	-	0.55	2.57	857 137	-	-	-	-	92	520	
Salmita Division	160	-	-	-	-	2.64	12.0	32 905	-	-	-	-	63	365	Mine closed mid-1987; milling continued to 1988.
Nanisivik Mines Ltd. Baffin Island	1 995	-	-	0.40	10.0	40.11	-	675 900	-	-	1 146	64 834	21 575	-	
NERCO Minerals Company Con and Ryon mines Yellowknife	725	-	-	-	-	3.39	13.03	193 838	-	-	-	-	591	2 426	
Pine Point Mines Limited Pine Point	9 980	-	-	3.3	9.7	-	-	888 315	-	-	28 093	82 829	-	-	Mine closed mid-1987. Milling continued to April 1988.
CANADA	607 485	0.62	0.15	0.29	0.96	13.26	0.90	161 422 462	781 532	217 755	402 925	1 414 897	1 482 058	127 774	

- Nil.

Note: Excludes several mines/mills in production in 1988 as follows: East Kemptville tin mine of Rio Algom Limited and Gays River mill of Westminer Canada Limited in Nova Scotia; Golden Rose mill of Noramco Mining Corporation, Hellens-Eplett mill (a small silver operation) of Silverside Resources Inc. and International Platinum Corporation, GoMill and Timmins heap leaching plant of Giant Yellowknife Mines Limited, Tyranite mill (treating old mine tailings) of Tyranex Gold Inc. and Mill City Gold Mining Corp. in Ontario; Hedley mine tailings treatment plant of Candorado Mines Ltd. and Cantrell Resources Ltd., Pilot Bay mill (a small zinc-lead-silver-gold operation) of Savoy Minerals Ltd., and union heap leach pad of Sumac Ventures Inc., in British Columbia. Estimated production from these 11 plants amounts to less than 1% of the Canadian total production of gold, silver and zinc, and less than 2% of copper. The above totals represent the metals in all of the concentrates produced, and do not represent the total metal recovered. All metallurgical treatment methods involve metal losses; further, some metals in other concentrates (e.g., copper in zinc concentrates) may be sent to facilities where only the principal metal is recovered.

Statistical Report

This statistical summary of the mineral industry in Canada was compiled by the staff of the Mineral and Metal Statistics Division, Mineral Policy Sector, Energy, Mines and Resources Canada. Inquiries for information may be addressed to the Division's statistical supervisor, Mrs. T. Newman at (613) 992-7108.

Statistics contained in this summary are obtained from a variety of sources. Principal sources include the statistical survey program of Energy, Mines and Resources Canada, Statistics Canada and Labour Canada. The statistical survey program of the Mineral and Metal Statistics Division is conducted jointly with the provincial governments and Statistics Canada in order to minimize the reporting burden on the mineral industry. The cooperation of the companies providing information is greatly appreciated.

Sources for the international mineral statistics include the U.S. Bureau of Mines, the American Bureau of Metal Statistics, the World Bureau of Metal Statistics, "Metals Week," Metallgesellschaft and the "Engineering and Mining Journal."

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CANADA, GENERAL ECONOMIC INDICATORS, 1974–88

		1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988[p]
Gross domestic product, current dollars	$ million	152 111	171 540	197 924	217 879	241 604	276 069	309 891	355 994	374 750	405 425	444 735	479 988[r]	504 631[r]	550 334	601 508
Gross domestic product, constant dollars (1981 = 100)	"	276 006	283 187	300 638	311 347	325 751	338 362	343 384	355 994	344 082	354 780	377 865	395 878[r]	408 143[r]	426 411	447 779
Mining's gross domestic product (1981 = 100)	"	23 776	19 521	19 586	18 894	17 879	20 215	19 660	17 453	16 463	17 019	20 606[r]	21 516[r]	20 388[r]	21 554[r]	23 451[r]
Manufacturing's gross domestic product (1981 = 100)	"	55 294	51 601	55 382	57 391	60 006	62 254	59 461	61 648	54 844	57 954	64 598[r]	68 235[r]	69 016[r]	73 000[r]	77 428[r]
Industrial production's gross domestic product (1981 = 100)	"	81 135	75 171	80 223	82 920	85 799	89 491	86 880	88 675	80 910	84 982	95 499[r]	100 811[r]	100 732[r]	106 421[r]	112 991[r]
Value of manufacturing industry shipments	"	82 455	88 427	98 076	109 747	129 019	152 133	165 985	190 851	183 652	200 155	229 848	248 673[r]	253 343[r]	268 536	288 549
Value of mineral production	"	11 754	13 347	15 693	18 473	20 319	26 135	31 926	32 420	33 831	38 540	43 789	44 730	32 446	36 361[r]	37 080
Merchandise exports	"	32 738	33 616	38 166	44 495	53 361	65 582	76 681	84 432	84 560	90 700	112 219	120 258	119 889	126 120	137 294
Merchandise imports	"	30 903	33 962	36 606	41 523	49 048	61 157	67 903	77 140	66 739	73 054	91 493	102 783	110 079	114 767	127 486
Balance of payments, current account	"	−1 299	−4 631	−4 096	−4 322	−4 903	−4 864	−1 130	−6 131	2 906	2 942	2 695	−1 991[r]	−10 578[r]	−9 360	−10 316
Corporation profits before taxes	"	20 062	19 663	19 985	21 090	25 360	34 884	36 456	32 638	21 110	32 684	45 855	49 490[r]	45 199[r]	56 270	62 268
Business investment, current dollars	"	30 370	35 602	40 462	43 485	47 496	56 096	64 065	76 672	71 067	70 862	73 309	81 312[r]	88 792[r]	102 292	117 679
Business investment, constant dollars (1981 = 100)	"	46 555	49 418	52 453	53 587	55 638	61 399	68 103	76 672	67 088	65 972	67 635	73 870[r]	78 949[r]	89 052	101 672
Population	000s	22 364	22 697	22 993	23 258	23 476	23 671	23 936	24 342	24 634	24 886	25 124	25 360	25 353	25 617	25 912
Labour force	"	9 639	9 974	10 203	10 500	10 895	11 231	11 573	11 904	11 958	12 183	12 399	12 639	12 870	13 011	13 275
Employed	"	9 125	9 284	9 477	9 651	9 987	10 395	10 708	11 006	10 644	10 734	11 000	11 311	11 634	11 861	12 244
Unemployed	"	514	690	726	849	908	836	865	898	1 314	1 448	1 399	1 328	1 236	1 150	1 031
Unemployment rate	percent	5.3	6.9	7.1	8.1	8.3	7.4	7.5	7.5	11.0	11.9	11.3	10.5	9.6	8.8	7.8
Labour income	$ million	81 656	95 277	110 419	122 476	133 383	150 172	169 736	196 002	209 449	219 352	236 257[r]	254 777[r]	271 809[r]	296 002	322 717
Consumer price index	1981 = 100	52.8	58.5	62.9	67.9	73.9	80.7	88.9	100.0	110.8	117.2	121.8[r]	126.3[r]	131.0[r]	136.3	141.4

[p] Preliminary. [r] Revised

TABLE 1. MINERAL PRODUCTION OF CANADA, 1988 AND 1989, AND AVERAGE 1985–89

	Unit of Measure	1988		1989^p		Average 1985-89	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
Metals							
Antimony	kg	3 171	8 094	2 422	5 980	2 836	8 516
Bismuth	kg	181	2 811	164	2 432	173	2 470
Cadmium	kg	1 664	31 747	1 692	27 739	1 608	16 003
Calcium	kg	x	x	x	x	413	4 500
Cesium, pollucite	kg	x	x	x	x	125	447
Cobalt	kg	2 398	45 090	2 337	45 507	2 318	51 167
Copper	kg	758 478	2 393 568	706 117	2 414 572	739 182	1 924 909
Germanium	kg	-	-	x	x	x	x
Gold	g	134 813	2 331 989	158 440	2 297 747	119 906	1 948 630
Ilmenite	t	x	x	x	x	479	16 913
Indium	g	x	x	x	x	5 626	1 412
Iron ore	t	39 934	1 323 249	40 773	1 492 921	38 815	1 403 342
Iron remelt	t	x	x	x	x	731	170 704
Lead	kg	351 148	356 064	275 800	287 383	320 559	284 152
Lithium	kg	x	x	x	x	697	2 825
Magnesium	kg	x	x	x	x	7 997	35 258
Molybdenum	kg	13 535	121 105	13 716	122 364	12 225	106 851
Nickel	kg	198 744	2 790 417	196 133	3 079 907	183 515	1 867 971
Niobium (Nb_2O_5)	kg	x	x	x	x	3 172	20 029
Platinum group	g	12 541	190 914	10 375	143 853	11 314	170 348
Rare earths	t	x	x	x	x	34	1 369
Rhenium	kg	x	x	x	x	1	1 074
Rubidium	kg	x	x	-	-	x	x
Selenium	kg	321	8 790	363	7 097	366	7 593
Silver	kg	1 443	386 271	1 262	263 308	1 273	336 499
Strontium	kg	x	x	x	x	50	1 356
Tantalum (Ta_2O_5)	kg	18	1 695	36	3 328	34	2 780
Tellurium	kg	19	1 007	38	1 500	22	854
Tin	kg	x	x	x	x	2 638	24 921
Tungsten (WO_3)	kg	x	x	x	x	1 300	10 454
Uranium (U)	kg	12 066	1 018 665	11 564	989 659	11 837	1 046 999
Yttrium (Y_2O_3)	kg	x	x	x	x	46	1 878
Zinc	kg	1 370 000	2 264 611	1 315 274	2 843 622	1 176 132	1 819 973
Total metals			13 607 895		14 328 979		11 281 223
Nonmetals							
Arsenious trioxide	t	x	2 366	x	1 248	5	1 306
Asbestos	t	710	251 088	691	258 691	696	256 083
Barite	t	51	4 014	42	3 889	49	4 347
Fluorspar	t	x	x	x	x	22	3 150
Gemstone	kg	488	2 143	529	2 178	373	1 611
Graphite	t	x	x	x	x	3	1 654
Gypsum	t	9 512	92 544	8 457	81 519	8 725	83 057
Magnesite	t	x	x	x	x	156	19 929
Marl	t	x	x	x	x	6	84
Mica	t	x	x	x	x	14	5 070
Nepheline syenite	t	540	21 775	626	25 500	521	20 952
Peat	t	736	82 832	695	77 229	695	75 894
Perlite	t	x	x	x	x	1	64
Potash (K_2O)	t	8 154	1 167 747	7 036	946 960	7 254	814 713
Potassium sulphate	t	x	x	x	x	1	285
Quartz[1]	t	..	..	..	..	1 594	25 834
Salt	t	10 687	246 722	11 350	270 179	10 517	242 071
Serpentine	t	x	x	x	x	5	670
Soapstone, talc and pyrophyllite	t	146	16 023	146	15 400	13	1465
Sodium sulphate	t	331	25 016	370	25 031	356	28 695
Sulphur in smelter gas	t	856	85 179	831	83 048	798	81 464
Sulphur, elemental	t	5 981	444 007	5 183	440 696	6 408	658 279
Titanium dioxide	t	x	x	x	x	729	239 752
Tremolite	t	x	x	x	x	215	32
Total nonmetals			2 717 192		2 540 886		2 579 031

TABLE 1. (cont'd)

	Unit of Measure	1988		1989^p		Average 1985-89	
	(000)	(Quantity)	($000)	(Quantity)	($000)	(Quantity)	($000)
Fuels							
Coal	t	70 644	1 804 330	71 000	1 835 500	64 220	1 770 430
Natural gas	000 m^3	90 911	5 207 061	92 837	5 222 026	83 651	5 742 998
Natural gas by-products	m^3	22 556	1 593 637	23 144	1 635 119	21 214	1 943 458
Petroleum, crude	m^3	93 806	9 167 921	90 427	10 668 545	88 881	12 002 432
Total fuels			17 772 949		19 361 190		21 458 317
Structural materials							
Clay products	$	..	196 724	..	214 964	..	188 041
Cement	t	12 350	971 293	12 550	998 170	11 661	915 878
Lime	t	2 518	191 672	2 616	207 223	2 384	184 040
Sand and gravel	t	289 763	861 214	277 122	837 806	271 932	754 217
Stone	t	122 030	642 267	116 657	632 599	107 242	550 633
Total structural materials			2 863 171		2 890 762		2 592 809
Other minerals			-		-		12 546
Total all minerals			36 961 207		39 121 818		37 923 926

[1] Beginning in 1988, production for quartz is included in sand and gravel.

p Preliminary; .. Not available; – Nil; x Confidential.

Note: Totals may not add due to rounding. Confidential values are included in totals.

TABLE 2. CANADA, VALUE OF MINERAL PRODUCTION, PER CAPITA VALUE OF MINERAL PRODUCTION, AND POPULATION, 1960–89

	Metallics	Industrial Minerals	Fuels	Other Minerals[1]	Total	Per Capita Value of Mineral Production	Population of Canada
			($ million)			($)	(000)
1960	1 407	520	566		2 493	139.48	17 870
1961	1 387	542	674		2 603	142.72	18 238
1962	1 496	574	811		2 881	155.05	18 583
1963	1 510	632	885		3 027	159.91	18 931
1964	1 702	690	973		3 365	174.44	19 291
1965	1 908	761	1 046		3 715	189.11	19 644
1966	1 985	844	1 152		3 981	198.88	20 015
1967	2 285	861	1 235		4 381	214.98	20 378
1968	2 493	886	1 343		4 722	228.12	20 701
1969	2 378	893	1 465		4 736	225.51	21 001
1970	3 073	931	1 718		5 722	268.68	21 297
1971	2 940	1 008	2 015		5 963	276.46	21 568
1972	2 956	1 085	2 367		6 408	293.92	21 802
1973	3 850	1 293	3 227		8 370	379.69	22 043
1974	4 821	1 731	5 202		11 753	525.55	22 364
1975	4 796	1 898	6 653		13 347	588.05	22 697
1976	5 315	2 269	8 109		15 693	682.51	22 993
1977	5 988	2 612	9 873		18 473	794.24	23 258
1978	5 698	2 986	11 578		20 261	863.05	23 476
1979	7 951	3 514	14 617		26 081	1 101.83	23 671
1980	9 697	4 201	17 944		31 842	1 330.29	23 936
1981	8 753	4 485	19 046	136	32 420	1 331.86	24 342
1982	6 874	3 703	23 038	216	33 831	1 373.37	24 634
1983	7 399	3 741	27 154	245	38 539	1 548.68	24 885
1984	8 670	4 318	30 399	401	43 789	1 742.92	25 124
1985	8 709	4 859	31 120	41	44 730	1 763.79	25 360
1986	8 798	4 863	18 763	22	32 446	1 279.77	25 353
1987	10 962	5 125r	20 274	–	36 361r	1 419.39r	25 617r
1988	13 608	5 580	17 773	–	36 961	1 426.42	25 912
1989p	14 329	5 432	19 361	–	39 122	1 492.15	26 219

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[1] 1981–86 – Other minerals may include arsenious trioxide, bentonite, calcium, cesium, cobalt, diatomite, ilmenite, indium, iron remelt, lithium, marl, magnesium, niobium, perlite, rhenium, serpentine, sodium antimonate, strontium, tin, tungsten or yttrium for which the value of production may be confidential in that year. Beginning in 1987, this category was discontinued.

p Preliminary; r Revised; – Nil.

Note: Beginning in 1986, bentonite, diatomite and sodium antimonate are reported in industrial minerals. Totals may not add due to rounding.

TABLE 3. CANADA, VALUE OF MINERAL PRODUCTION

Year	Total Value ($000)	Value per capita ($)
1886	10 221	2.23
1890	16 763	3.51
1895	20 506	4.09
1900	64 421	12.15
1905	69 079	11.51
1910	106 824	15.29
1915	137 109	17.18
1920	227 860	26.63
1925	226 583	24.38
1930	279 874	27.42
1935	312 344	28.84
1940	529 825	46.55
1945	498 755	41.31
1950[1]	1 045 450	76.24
1955	1 793 311	114.37
1960	2 492 510	139.48
1965	3 714 861	189.11
1970	5 722 059	268.68
1975	13 346 994	588.05
1980	31 841 758	1 330.29
1981	32 420 159	1 331.86
1982	33 831 494	1 373.37
1983	38 539 005	1 548.68
1984	43 789 031	1 742.92
1985	44 729 629	1 763.79
1986	32 445 952	1 279.77
1987	36 361 024	1 419.39
1988	36 961 207	1 426.42
1989[p]	39 121 818	1 492.15

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[1] Value of Newfoundland production included from 1950.
[p] Preliminary.

TABLE 4. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1988

	Metals		Industrial minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	472	. . .	765 071	13.7	14 296 414	80.4	15 061 958	40.8
Ontario	5 226 357	38.4	1 588 883	28.5	81 050	0.5	6 896 291	18.7
British Columbia	1 961 596	14.4	389 096	7.0	1 592 399	9.0	3 943 091	10.7
Saskatchewan	609 464	4.5	1 089 273	19.5	1 344 319	7.6	3 043 056	8.2
Quebec	1 660 151	12.2	1 051 238	18.8	–	–	2 711 389	7.3
Manitoba	1 425 639	10.5	121 998	2.2	78 927	0.4	1 626 564	4.4
Northwest Territories	805 636	5.9	20 851	0.4	130 410	0.7	956 897	2.6
New Brunswick	604 046	4.4	273 227	4.9	33 530	0.2	910 803	2.5
Newfoundland	788 411	5.8	75 337	1.4	–	–	863 748	2.3
Yukon	486 832	3.6	5 367	0.1	–	–	492 199	1.3
Nova Scotia	39 290	0.3	197 883	3.5	215 900	1.2	453 073	1.2
Prince Edward Island	–	–	2 138	. . .	–	–	2 138	. . .
Total	13 607 895	100.0	5 580 363	100.0	17 772 949	100.0	36 961 207	100.0

– Nil; . . . Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 4a. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES, TERRITORIES AND MINERAL CLASSES, 1989p

	Metals		Industrial minerals		Fuels		Total	
	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)	($000)	(% of total)
Alberta	80	...	744 104	13.7	15 463 015	79.9	16 207 199	41.4
Ontario	5 564 521	38.8	1 660 160	30.6	84 123	0.4	7 308 805	18.7
British Columbia	1 912 859	13.3	421 025	7.8	1 757 338	9.1	4 091 222	10.5
Saskatchewan	573 792	4.0	895 649	16.5	1 547 752	8.0	3 017 193	7.7
Quebec	1 749 727	12.2	1 062 675	19.6	–	–	2 812 402	7.2
Manitoba	1 476 619	10.3	121 424	2.2	88 791	0.5	1 686 833	4.3
Northwest Territories	950 857	6.6	14 781	0.3	179 071	0.9	1 144 709	2.9
Newfoundland	885 363	6.2	73 850	1.4	–	–	959 213	2.5
New Brunswick	639 524	4.5	236 223	4.3	33 800	0.2	909 547	2.3
Yukon	534 458	3.7	5 422	0.1	–	–	539 880	1.4
Nova Scotia	41 181	0.3	194 157	3.6	207 300	1.1	442 638	1.1
Prince Edward Island	–	–	2 177	...	–	–	2 177	...
Total	14 328 979	100.0	5 431 648	100.0	19 361 190	100.0	39 121 818	100.0

p Preliminary; – Nil; ... Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 5. CANADA, PERCENTAGE CONTRIBUTION OF LEADING MINERALS TO TOTAL VALUE OF MINERAL PRODUCTION, 1983–89

	1983	1984	1985	1986	1987	1988	1989P
Petroleum, crude	41.8	40.6	41.2	29.6	33.4	24.8	27.3
Natural gas	18.4	18.1	18.0	17.3	12.7	14.1	13.3
Nickel	2.0	2.7	2.7	3.0	3.5	7.5	7.9
Zinc	2.9	3.4	2.9	3.7	4.1	6.1	7.3
Copper	3.5	3.1	3.3	4.4	5.3	6.5	6.2
Gold	3.2	2.9	2.7	5.2	6.1	6.3	5.9
Coal	3.4	4.1	4.1	5.3	4.5	4.9	4.7
Natural gas by-products	7.0	6.5	6.3	5.6	5.2	4.3	4.2
Iron ore	3.3	3.4	3.3	4.1	3.8	3.6	3.8
Cement	1.6	1.6	1.8	2.5	2.7	2.6	2.6
Uranium (U)	1.7	2.1	2.2	3.2	3.3	2.8	2.5
Potash (K_2O)	1.7	2.0	1.4	1.8	2.0	3.2	2.4
Sand and gravel	1.6	1.2	1.4	2.1	2.1	2.3	2.1
Stone	0.8	0.9	0.9	1.5	1.6	1.7	1.6
Sulphur, elemental	1.1	1.4	2.3	2.6	1.4	1.2	1.1
Lead	0.4	0.4	0.3	0.7	1.1	1.0	0.7
Salt	0.4	0.5	0.5	0.7	0.7	0.7	0.7
Silver	1.4	1.1	0.7	0.8	1.2	1.0	0.7
Asbestos	1.0	0.9	0.7	0.7	0.7	0.7	0.7
Clay products	0.3	0.3	0.3	0.6	0.6	0.5	0.5
Lime	0.4	0.4	0.4	0.5	0.5	0.5	0.5
Platinum group	0.2	0.3	0.3	0.6	0.5	0.5	0.4
Molybdenum	0.2	0.2	0.2	0.3	0.2	0.3	0.3
Sulphur in smelter gas	0.1	0.1	0.2	0.2	0.3	0.2	0.2
Gypsum	0.2	0.1	0.2	0.3	0.2	0.3	0.2
Other minerals	1.4	1.7	1.7	2.7	2.3	2.4	2.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

P Preliminary.

Note: Totals may not add due to rounding.

TABLE 6. CANADA, PRODUCTION OF LEADING MINERALS, 1988 AND 1989

	1988	1989^p	Percent change 1989/1988	1988	1989^p	Percent change 1989/1988
	(000 tonnes except where noted)			($ millions)		
Metals						
Nickel	198.7	196.1	-1.3	2 790.4	3 079.9	10.4
Zinc	1 370.0	1 315.3	-4.0	2 264.6	2 843.6	25.6
Copper	758.5	706.1	-6.9	2 393.6	2 414.6	0.9
Gold (kg)	134 812.6	158 439.7	17.5	2 332.0	2 297.7	-1.5
Iron ore	39 933.9	40 773.1	2.1	1 323.2	1 492.9	12.8
Uranium (tU)	12 065.8	11 563.6	-4.2	1 018.7	989.7	-2.8
Lead	351.1	275.8	-21.5	356.1	287.4	-19.3
Silver (t)	1 443.2	1 262.2	-12.5	386.3	263.3	-31.8
Platinum group (kg)	12 541.2	10 375.2	-17.3	190.9	143.9	-24.7
Molybdenum (t)	13 535.2	13 716.1	1.3	121.1	122.4	1.0
Nonmetals						
Potash (K_2O)	8 154.4	7 035.5	-13.7	1 167.7	947.0	-18.9
Sulphur, elemental	5 981.5	5 183.4	-13.3	444.0	440.7	-0.7
Salt	10 687.2	11 349.8	6.2	246.7	270.2	9.5
Asbestos	710.4	691.4	-2.7	251.1	258.7	3.0
Sulphur in smelter gas	856.5	831.2	-2.9	85.2	83.0	-2.5
Gypsum	9 511.6	8 456.8	-11.1	92.5	81.5	-11.9
Structurals						
Cement	12 349.9	12 550.4	1.6	971.3	998.2	2.8
Sand and gravel	289 763.2	277 122.4	-4.4	861.2	837.8	-2.7
Stone	122 029.9	116 656.7	-4.4	642.3	632.6	-1.5
Clay products	. .	. .	. .	196.7	215.0	9.3
Lime	2 518.0	2 616.5	3.9	191.7	207.2	8.1
Fuels						
Petroleum (000 m^3)	93 806.0	90 427.0	-3.6	9 167.9	10 668.5	16.4
Natural gas (million m^3)	90 911.0	92 837.0	2.1	5 207.1	5 222.0	0.3
Coal	70 644.0	71 000.0	0.5	1 804.3	1 835.5	1.7
Natural gas by-products (000 m^3)	22 556.0	23 144.0	2.6	1 593.6	1 635.1	2.6

^{p} Preliminary; . . Not applicable.

Note: Figures have been rounded.

TABLE 7. VALUE OF LEADING MINERALS IN THE PROVINCES, TERRITORIES AND CANADA, 1988 AND 1989

	Value of Production			
	1988^{r}	1989^{p}	Change 1989/1988	1989^{p} Proportion of Provincial Total
	($ million)		(percent)	
Newfoundland				
Iron ore	695.8	788.2	13.3	82.2
Zinc	52.6	64.4	22.4	6.7
Gold	x	x	x	x
Asbestos	26.9	24.2	-10.1	2.5
Stone, sand and gravel	25.9	22.2	-14.4	2.3
Total	863.7	959.2	11.1	
Prince Edward Island				
Sand and gravel	2.1	2.2	1.8	100.0
Total	2.1	2.2	1.8	
Nova Scotia				
Coal	215.9	207.3	-4.0	46.8
Gypsum	66.8	59.3	-11.1	13.4
Stone, sand and gravel	62.2	57.4	-7.7	13.0
Salt	x	x	x	x
Tin	x	x	x	x
Cement	x	x	x	x
Total	453.1	442.6	-2.3	
New Brunswick				
Zinc	431.6	485.6	12.5	53.4
Potash	x	x	x	x
Lead	75.6	71.2	-5.8	7.8
Silver	54.2	41.0	-24.4	4.5
Coal	33.5	33.8	0.8	3.7
Total	910.8	909.5	-0.1	
Quebec				
Iron ore	x	x	x	x
Gold	580.1	521.4	-10.1	18.5
Titanium dioxide	x	x	x	x
Stone	234.8	220.6	-6.0	7.8
Copper	150.3	205.9	37.0	7.3
Zinc	135.6	202.4	49.3	7.2
Total	2 711.4	2 812.4	3.7	
Ontario				
Nickel	1 742.5	2 029.9	16.5	27.8
Gold	1 080.5	1 170.5	8.3	16.0
Copper	904.2	892.9	-1.3	12.2
Zinc	540.0	578.2	7.1	7.9
Uranium	446.2	460.2	3.1	6.3
Cement	436.3	453.9	4.0	6.2
Total	6 896.3	7 308.8	6.0	
Manitoba				
Nickel	1 047.9	1 050.0	0.2	62.2
Copper	167.5	170.2	1.6	10.1
Zinc	88.8	156.8	76.5	9.3
Crude petroleum	78.6	88.5	12.6	5.2
Gold	77.3	60.7	-21.5	3.6
Total	1 626.6	1 686.8	3.7	

TABLE 7. (cont'd)

	Value of Production			
	1988[f]	1989[p]	Change 1989 1988	1989[p] Proportion of Provincial Total
	($ million)		(percent)	
Saskatchewan				
Crude petroleum	1 026.5	1 178.9	14.8	39.1
Potash	x	x	x	x
Uranium	572.5	529.5	-7.5	17.5
Total	3 043.1	3 017.2	-0.8	
Alberta				
Crude petroleum	7 710.7	8 960.5	16.2	55.3
Natural gas	4 584.5	4 420.6	-3.6	27.3
Natural gas by-products	1 542.4	1 579.0	2.4	9.7
Coal	458.9	503.0	9.6	3.1
Sulphur, elemental	419.5	400.8	-4.5	2.5
Total	15 062.0	16 207.2	7.6	
British Columbia				
Copper	1 137.9	1 113.9	-2.1	27.2
Coal	974.4	976.5	0.2	23.9
Natural gas	378.0	504.9	33.6	12.3
Zinc	236.1	282.5	19.6	6.9
Crude petroleum	206.0	236.9	15.0	5.8
Gold	226.0	210.8	-6.7	5.2
Total	3 943.1	4 091.2	3.8	
Yukon				
Zinc	237.9	341.6	43.6	63.3
Lead	x	x	x	x
Gold	87.4	80.5	-7.9	14.9
Silver	42.6	13.4	-68.6	2.5
Total	492.2	539.9	9.7	
Northwest Territories				
Zinc	537.8	728.4	35.5	63.6
Gold	205.5	174.8	-15.0	15.3
Crude petroleum	123.9	170.4	37.6	14.9
Lead	52.2	39.0	-25.3	3.4
Total	956.9	1 144.7	19.6	
Canada				
Crude petroleum	9 167.9	10 668.5	16.4	27.3
Natural gas	5 207.1	5 222.0	0.3	13.3
Nickel	2 790.4	3 079.9	10.4	7.9
Zinc	2 264.6	2 843.6	25.6	7.3
Copper	2 393.6	2 414.6	0.9	6.2
Gold	2 332.0	2 297.7	-1.5	5.9
Coal	1 804.3	1 835.5	1.7	4.7
Natural gas by-products	1 593.6	1 635.1	2.6	4.2
Iron ore	1 323.2	1 492.9	12.8	3.8
Cement	971.3	998.2	2.8	2.6
Total	36 961.2	39 121.8	5.8	

[f] Final; [p] Preliminary; x Confidential.

TABLE 8. PRODUCTION OF LEADING MINERALS, BY PROVINCES AND TERRITORIES IN CANADA, 1988

	Unit of Measure	Nfld	P E I	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N W T	Total Canada
Petroleum, crude	000 m³	-	-	-	-	-	191	769	12 168	76 958	1 887	-	1 833	93 806
	$000	-	-	-	-	-	22 336	78 600	1 026 467	7 710 659	205 978	-	123 881	9 167 921
Natural gas	million m³	-	-	-	-	-	509	-	3 449	77 995	8 820	-	138	90 911
	$000	-	-	-	-	-	58 714	-	180 481	4 584 528	378 012	-	5 326	5 207 061
Nickel	000 t	-	-	-	-	-	129	70	-	-	-	-	-	199
	$000	-	-	-	-	-	1 742 507	1 047 910	-	-	-	-	-	2 790 417
Copper	000 t	-	-	x	8	48	287	53	2	-	361	x	...	758
	$000	-	-	x	25 139	150 319	904 235	167 483	6 842	-	1 137 869	x	3	2 393 568
Gold	kg	x	-	x	393	33 538	62 463	4 469	1 480	27	13 067	5 052	11 880	134 813
	$000	x	-	x	6 803	580 147	1 080 478	77 301	25 598	472	226 029	87 386	205 503	1 331 989
Zinc	000 t	32	-	x	261	82	327	54	x	-	143	144	325	1 370
	$000	52 594	-	x	431 581	135 597	540 032	88 843	x	-	236 102	237 932	537 756	2 264 611
Coal	000 t	-	-	3 544	542	-	-	-	12 148	29 468	24 942	-	-	70 644
	$000	-	-	215 900	33 530	-	-	-	121 650	458 850	974 400	-	-	1 804 330
Natural gas by-products	000 m³	-	-	-	-	-	-	5	242	21 699	592	-	18	22 556
	$000	-	-	-	-	-	-	327	15 721	1 542 377	34 009	-	1 203	1 593 637
Iron ore	000 t	20 507	-	-	-	16 433	2 934	-	-	-	59	-	-	39 934
	$000	695 759	-	-	-	x	x	-	-	-	2 203	-	-	1 323 249
Potash (K₂O)	000 t	-	-	-	x	-	-	-	x	-	-	-	-	8 154
	$000	-	-	-	x	-	-	-	x	-	-	-	-	1 267 747
Uranium (U)	000 t	-	-	-	-	-	4	-	8	-	-	-	-	12
	$000	-	-	-	-	-	446 178	-	572 487	-	-	-	-	1 018 665
Cement	000 t	x	-	x	x	3 254	5 353	x	x	x	x	-	-	12 350
	$000	x	-	x	x	189 364	436 269	x	x	x	x	-	-	971 293
Sand and gravel	000 t	5 370	922	9 483	9 429	37 590	104 838	14 189	12 239	42 361	48 658	2 240	2 443	289 763
	$000	18 668	2 138	27 726	18 291	99 146	336 156	45 158	33 043	141 504	123 233	5 184	10 966	861 214
Stone	000 t	1 023	-	6 567	2 445	46 450	58 460	2 877	-	528	3 571	-	108	122 030
	$000	7 248	-	34 453	15 266	234 775	313 141	12 537	-	3 350	21 264	-	232	642 267
Sulphur, elemental	000 t	-	-	-	-	-	-	-	3	5 667	312	-	-	5 981
	$000	-	-	-	-	-	-	-	258	419 500	24 248	-	-	444 007
Silver	t	x	-	x	203	140	434	32	x	-	447	159	26	1 443
	$000	x	-	x	54 236	37 382	116 249	8 634	x	-	119 605	42 593	6 923	386 271
Lead	000 t	-	-	-	75	-	2		-	-	105	117	52	351
	$000	-	-	-	75 587	-	2 520	463	-	-	106 575	118 696	52 223	356 064
Asbestos	000 t	72	-	-	-	530	-	-	-	-	109	-	-	710
	$000	26 895	-	-	-	169 951	-	-	-	-	54 242	-	-	251 088
Salt	000 t	-	-	x	x	x	6 599	-	410	1 256	-	-	-	10 687
	$000	-	-	x	x	x	154 642	-	24 099	15 865	-	-	-	246 722
Clay products	$000	x	-	x	x	x	131 738	x	x	x	x	-	-	196 724
Lime	000 t	-	-	-	x	x	1 659	x	-	180	166	-	-	2 518
	$000	-	-	-	x	x	118 632	8 275	-	17 230	14 834	-	-	191 672
Platinum group	kg	-	-	-	-	-	x	x	-	-	-	-	-	12 541
	$000	-	-	-	-	-	x	x	-	-	-	-	-	190 914
Molybdenum	t	-	-	-	-	-	-	-	-	-	13 535	-	-	13 535
	$000	-	-	-	-	-	-	-	-	-	121 105	-	-	121 105
Gypsum	t	x	-	7 245	x	-	1 453	x	-	-	419	-	-	9 512
	$000	x	-	66 776	x	-	15 716	x	-	-	4 936	-	-	92 544
Sulphur in smelter gas	000 t	-	-	2	121	22	545	-	-	-	91	2	73	856
	$000	-	-	282	17 127	4 358	46 953	-	-	-	8 989	183	7 286	85 179
Total leading minerals	$000	854 314	2 138	(1)	874 662	2 180 165	6 756 229	1 601 312	3 018 039	15 044 122	3 909 064	(1)	951 304	36 100 259
Total all minerals	$000	863 748	2 138	453 073	910 803	2 711 389	6 896 291	1 626 564	3 043 056	15 061 958	3 943 091	492 199	956 897	36 961 207
Leading minerals as % of all minerals		99 8	100 0	(1)	96 0	80 4	98 0	98 4	99 2	99 9	99 1	(1)	99 4	97 7

(1) Excluded to retain confidentiality

- Nil, . . . Amount too small to be expressed, x Confidential

Note Totals may not add due to rounding Confidential values included in totals

TABLE 8a. PRODUCTION OF LEADING MINERALS, BY PROVINCES AND TERRITORIES IN CANADA, 1989p

	Unit of Measure	Nfld	P.E.I.	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia	Yukon	N.W.T.	Total Canada
Petroleum, crude	000 m³	–	–	–	–	–	244	717	11 508	74 214	1 860	–	1 884	90 427
	$000	–	–	–	–	–	33 334	88 489	1 178 890	8 960 488	236 919	–	170 425	10 668 545
Natural gas	million m³	–	–	–	–	–	493	–	4 954	76 864	10 403	–	123	92 837
	$000	–	–	–	–	–	50 789	–	239 729	4 420 557	504 937	–	6 014	5 222 026
Nickel	000 t	–	–	–	–	–	132	65	–	–	–	–	–	196
	$000	–	–	–	–	–	2 029 897	1 050 010	–	–	–	–	–	3 079 907
Zinc	000 t	30	–	x	225	94	267	73	x	–	131	158	337	1 315
	$000	64 357	–	x	485 620	202 441	578 239	156 785	x	–	282 483	341 649	728 401	2 843 622
Copper	000 t	–	–	x	8	60	261	50	1	–	326	x	...	706
	$000	–	–	x	28 259	205 915	892 892	170 163	2 137	–	1 113 911	x	3	2 414 572
Gold	kg	x	–	x	341	35 955	80 707	4 187	2 737	5	14 537	5 551	12 051	158 440
	$000	x	–	x	4 952	521 351	1 170 487	60 717	39 697	80	210 833	80 504	174 770	2 297 747
Coal	000 t	–	–	3 580	525	–	–	–	10 915	31 060	24 920	–	–	71 000
	$000	–	–	207 300	33 800	–	–	–	114 900	503 000	976 500	–	–	1 835 500
Natural gas by-products	000 m³	–	–	–	–	–	–	5	242	22 202	666	–	29	23 144
	$000	–	–	–	–	–	–	302	14 233	1 578 970	38 982	–	2 632	1 635 119
Iron ore	000 t	21 119	–	–	–	16 127	3 463	–	–	–	63	–	–	40 773
	$000	788 239	–	–	–	x	x	–	–	–	1 351	–	–	1 492 921
Cement	000 t	x	–	x	x	3 180	5 513	x	x	x	x	–	–	12 550
	$000	x	–	x	x	186 900	453 915	x	x	x	x	–	–	998 170
Uranium (U)	000 t	–	–	–	–	–	4	–	8	–	–	–	–	12
	$000	–	–	–	–	–	460 197	–	529 462	–	–	–	–	989 659
Potash (K₂O)	000 t	–	–	–	x	–	–	–	x	–	–	–	–	7 036
	$000	–	–	–	x	–	–	–	x	–	–	–	–	946 960
Sand and gravel	000 t	5 096	848	7 982	9 039	33 877	96 699	14 438	10 636	43 679	50 395	2 252	2 182	277 122
	$000	17 479	2 177	23 651	15 228	98 972	329 649	41 930	30 633	134 642	127 181	5 422	10 841	837 806
Stone	000 t	590	–	6 416	2 250	42 206	56 870	3 041	–	282	4 830	–	172	116 657
	$000	4 707	–	33 747	13 614	220 639	316 068	14 076	–	2 762	26 364	–	622	632 599
Sulphur, elemental	000 t	–	–	–	–	–	–	–	16	4 826	341	–	–	5 183
	$000	–	–	–	–	–	–	–	1 227	400 766	38 702	–	–	440 696
Lead	000 t	–	–	–	68	–	x	2	–	–	72	x	37	276
	$000	–	–	–	71 227	–	x	1 948	–	–	75 194	x	38 998	287 383
Salt	000 t	–	–	x	x	x	7 382	–	418	1 412	–	–	–	11 350
	$000	–	–	x	x	x	180 047	–	24 170	16 239	–	–	–	270 179
Silver	t	x	–	x	197	131	356	32	x	–	460	64	20	1 262
	$000	x	–	x	40 987	27 392	74 337	6 729	x	–	96 021	13 384	4 250	263 308
Asbestos	000 t	64	–	–	–	519	–	–	–	–	108	–	–	691
	$000	24 175	–	–	–	176 716	–	–	–	–	57 800	–	–	258 691
Clay products	$000	x	–	x	2 565	x	152 777	x	x	x	x	–	–	214 964
Lime	000 t	–	–	–	x	x	1 691	x	–	187	174	–	–	2 616
	$000	–	–	–	x	x	126 394	8 970	–	18 471	16 243	–	–	207 223
Platinum group	kg	–	–	–	–	–	x	x	–	–	–	–	–	10 375
	$000	–	–	–	–	–	x	x	–	–	–	–	–	143 853
Molybdenum	t	–	–	–	–	–	–	–	–	–	13 716	–	–	13 716
	$000	–	–	–	–	–	–	–	–	–	122 364	–	–	122 364
Sulphur in smelter gas	000 t	–	–	...	85	42	541	–	–	–	141	–	21	831
	$000	–	–	54	12 844	6 733	47 903	–	–	–	13 444	–	2 069	83 048
Gypsum	000 t	x	–	6 299	–	–	1 492	x	–	–	356	–	–	8 457
	$000	x	–	59 333	–	–	13 556	x	–	–	4 356	–	–	81 519
Total leading minerals	$000	948 428	2 177	404 202	879 428	2 269 737	7 179 850	1 661 590	2 991 680	16 192 179	4 060 337	539 749	1 139 026	38 268 382
Total all minerals	$000	959 213	2 177	442 638	909 547	2 812 402	7 308 805	1 686 833	3 017 193	16 207 199	4 091 222	539 880	1 144 709	39 121 818
Leading minerals as % of all minerals		98.9	100.0	91.3	96.7	80.7	98.2	98.5	99.2	99.9	99.2	99.98	99.5	97.8

p Preliminary; – Nil; ... Amount too small to be expressed; x Confidential

Note: Totals may not add due to rounding. Confidential values included in totals.

TABLE 9. CANADA'S TEN LEADING MINERAL COMMODITIES; VALUE OF PRODUCTION BY MINERAL AND PERCENT CONTRIBUTION TO VALUE OF CANADIAN PRODUCTION, BY PROVINCE OR TERRITORY, 1978 AND 1988

	Petroleum		Natural Gas		Nickel		Copper		Gold		Zinc		Coal		Natural Gas By products		Iron Ore		Potash	
	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
1978																				
Newfoundland		-	-	-	-	-	18 964	1.7	3 888	1.0	36 562	4.5		-	-	-	564 114	46.2	-	-
Prince Edward Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nova Scotia	-	-	-	-	-	-	-	-	-	-		-	120 722	15.5	-	-	-	-		-
New Brunswick	40	...	2	...	-	-	17 004	1.6	2 408	0.6	156 490	19.1	8 723	1.1	-	-	-	-	-	-
Quebec	-	-	-		-	-	148 274	13.7	107 213	28.0	73 191	9.0	-	-	-	-	337 512	27.6	-	-
Ontario	8 154	0.1	18 715	0.5	474 604	74.7	324 000	29.9	154 462	40.4	211 416	25.9	-	-	-	-	308 367	25.2	-	-
Manitoba	45 933	0.8	-	-	160 847	25.3	99 053	9.1	10 440	2.7	43 731	5.3	-	-	-	-	-	-	-	-
Saskatchewan	690 626	11.9	15 082	0.4	-	-	9 911	0.9	2 859	0.7	4 550	0.6	18 609	2.4	8 679	0.8	-	-	504 535	100.0
Alberta	4 913 264	84.6	3 590 518	91.5	-	-	-	-	246	0.1	-	-	256 905	33.0	1 033 348	97.1	-	-	-	-
British Columbia	146 716	2.5	266 684	6.8	-	-	450 046	41.5	46 620	12.2	73 596	9.0	374 467	48.0	21 643	2.0	11 597	0.9	-	-
Yukon	-	-	-	-	-	-	16 474	1.5	8 519	2.2	74 077	9.1	-	-	-	-	-	-	-	-
Northwest Territories	6 263	0.1	32 423	0.8	-	-	519	...	45 770	12.0	143 911	17.6	-	-	-	-	-	-	-	-
CANADA	5 810 996	100.0	3 923 424	100.0	635 451	100.0	1 084 245	100.0	382 425	100.0	817 614	100.0	779 426	100.0	1 063 670	100.0	1 221 590	100.0	504 535	100.0
1988																				
Newfoundland	-	-	-	-	-	-	-	-	x	1.7	52 594	2.3	-	-	-	-	695 759	52.6	-	-
Prince Edward Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nova Scotia	-	-	-	-	-	-	x	x	x	x	x	x	215 900	12.0	-	-	-	-	-	-
New Brunswick	-	-	-	-	-	-	25 139	1.1	6 803	0.3	431 581	19.1	33 530	1.9	-	-	-	-	x	x
Quebec	-	-	-	-	-	-	150 319	6.3	580 147	24.9	135 597	6.0	-	-	-	-	x	x	-	-
Ontario	22 336	0.2	58 714	1.1	1 742 507	62.4	904 235	37.8	1 080 478	46.3	540 032	23.8		-	-	-	x	x	-	-
Manitoba	78 600	0.9	-	-	1 047 910	37.6	167 483	7.0	77 301	3.3	88 843	3.9	-	-	327	...	-	-	-	-
Saskatchewan	1 026 467	11.2	180 481	3.5	-	-	6 842	0.3	25 598	1.1	x	x	121 650	6.7	15 721	1.0	-	-	x	x
Alberta	7 710 659	84.1	4 584 520	88.0	-	-	-	-	472		-	-	458 850	25.4	1 542 377	96.8	-	-	-	-
British Columbia	205 378	2.2	378 012	7.3	-	-	1 137 869	47.5	226 029	9.7	236 102	10.4	974 400	54.0	34 009	2.1	2 203	0.2	-	-
Yukon	-	-	-	-	-	-	x	x	87 386	3.7	237 932	10.5	-	-	-	-	-		-	-
Northwest Territories	123 881	1.4	5 326	0.1	-	-	3		205 503	8.8	537 756	23.7	-	-	1 203	0.1	-			-
CANADA	9 167 921	100.0	5 207 061	100.0	2 790 417	100.0	2 393 568	100.0	2 331 989	100.0	2 264 611	100.0	1 804 330	100.0	1 593 637	100.0	1 323 249	100.0	1 167 747	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogues #26-201 and #26-202.
- Nil; x Confidential; ... Amount too small to be expressed.

TABLE 9a. CANADA'S TEN LEADING MINERAL COMMODITIES; VALUE OF PRODUCTION BY MINERAL AND PERCENT CONTRIBUTION TO VALUE OF CANADIAN PRODUCTION, BY PROVINCE OR TERRITORY, 1979 AND 1989

	Petroleum		Natural Gas		Nickel		Zinc		Copper		Gold		Coal		Natural Gas By products		Iron Ore		Cement	
	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)	($000)	(%)
1979																				
Newfoundland			-	-		-	50 547	4.8	19 495	1.3	4 580	0.8				-	963 943	53.3	6 784	1.0
Prince Edward Island		-	-	-	-	-	-	-			-	-	-	-	-	-	-	-	-	-
Nova Scotia	-	-	-	-	-	-	-	-	-	-	-	-	99 675	11.6	-	-	-	-	17 238	2.6
New Brunswick	39	-	20	-	-	-	206 099	19.4	27 591	1.8	2 902	0.5	10 310	1.2	-	-	-	-	13 501	2.1
Quebec	-	-	-	-	-	-	76 070	7.2	190 227	12.6	170 054	28.8	-	-	-	-	543 257	30.1	132 952	20.3
Ontario	8 259	0.1	21 420	0.4	566 279	68.3	278 881	26.3	457 472	30.3	221 474	37.5	-	-	-	-	287 191	15.9	222 966	34.1
Manitoba	48 403	0.6	-	-	262 338	31.7	43 900	4.1	138 236	9.1	15 716	2.7	-	-	-	-	-	-	45 530	7.0
Saskatchewan	728 985	9.8	22 477	0.4	-	-	4 328	0.4	13 502	0.9	4 331	0.7	23 695	2.8	11 768	0.8	-	-	30 524	4.7
Alberta	6 486 869	87.1	4 918 931	91.8	-	-	-	-			482	0.1	238 185	27.7	1 408 254	97.2	-	-	97 482	14.9
British Columbia	171 845	2.3	392 588	7.3	-	-	85 217	8.0	645 293	42.7	95 610	16.2	488 135	56.8	28 993	2.0	13 008	0.7	86 900	13.3
Yukon	-	-	-	-	-	-	109 461	10.3	18 442	1.2	13 749	2.3	-	-	-	-	-	-	-	-
Northwest Territories	7 455	0.1	409		-	-	205 600	19.4	942	0.1	61 868	10.5	-	-	-	-	-	-	-	-
CANADA	7 451 855	100.0	5 355 845	100.0	828 617	100.0	1 060 103	100.0	1 511 200	100.0	590 766	100.0	860 000	100.0	1 449 015	100.0	1 807 399	100.0	653 877	100.0
1989p																				
Newfoundland	-	-	-	-	-	-	64 357	2.3	-	-	x	x			-	-	788 239	52.8	x	x
Prince Edward Island	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nova Scotia	-	-	-	-	-	-	x	x	x	x	x	x	207 300	11.3	-	-	-	-	x	x
New Brunswick	-	-	-	-	-	-	485 620	17.1	28 259	1.2	4 952	0.2	33 800	1.8	-	-	-	-	x	x
Quebec	-	-	-	-	-	-	202 441	7.1	205 915	8.5	521 351	22.7	-	-	-	-	x	x	186 900	18.7
Ontario	33 334	0.3	50 789	1.0	2 029 897	65.9	578 239	20.3	892 892	37.0	1 170 487	50.9			-	-	x	x	453 915	45.5
Manitoba	88 489	0.8		-	1 050 010	34.1	156 785	5.5	170 163	7.0	60 717	2.6	-	-	302	-	-	-	x	x
Saskatchewan	1 178 890	11.1	239 729	4.6	-	-	x	x	2 137	0.1	39 697	1.7	114 900	6.3	14 233	0.9	-	-	x	x
Alberta	8 960 488	84.0	4 420 557	84.7	-		-	-	-		80	...	503 000	27.4	1 578 970	96.6	-	-	x	x
British Columbia	236 919	2.2	504 937	9.7	-		282 483	9.9	1 113 911	46.1	210 833	9.2	976 500	53.2	38 982	2.4	1 351	0.1	x	x
Yukon	-	-	-	-	-	-	341 649	12.0	x	x	80 504	3.5	-	-	-	-	-	-	-	-
Northwest Territories	170 425	1.6	6 014	0.1	-	-	728 401	25.6	3		174 770	7.6	-	-	2 632	0.2	-	-	-	-
CANADA	10 668 545	100.0	5 222 026	100.0	3 079 907	100.0	2 843 622	100.0	2 414 572	100.0	2 297 747	100.0	1 835 500	100.0	1 635 119	100.0	1 492 921	100.0	998 170	100.0

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogues #26-201 and #26-202.

- Nil, x Confidential, ... Amount too small to be expressed, p Preliminary

TABLE 10. PRODUCTION OF CANADA'S TEN LEADING[1] MINERAL COMMODITIES, 1980 AND 1982–89

	Unit	1980	1982	1983	1984	1985	1986	1987	1988	1989p
Petroleum	000 m^3	83 477	73 790	78 751	83 680	85 564	85 468	89 140	93 806	90 427
Natural Gas	000 000 m^3	87 108	75 977	72 229	78 266	84 344	71 896	78 267	90 911	92 837
Nickel	000 kg	184 802	88 581	125 022	173 725	169 971	163 639	189 086	198 744	196 133
Zinc	000 kg	883 697	965 607	987 713	1 062 701	1 049 275	988 173	1 157 936	1 370 000	1 315 274
Copper	000 kg	716 363	612 455	653 040	721 826	738 637	698 527	794 149	758 478	706 117
Gold	000 g	50 620	64 735	73 512	83 446	87 562	102 899	115 818	134 813	158 440
Coal	000 t	36 677	42 811	44 787	57 402	60 436	57 811	61 211	70 644	71 000
Natural Gas By-products	000 m^3	19 147	18 466	18 013	19 640	19 682	19 127	21 560	22 556	23 144
Iron ore	000 t	49 068	33 198	32 959	39 930	39 502	36 167	37 702	39 934	40 773
Cement	000 t	10 274	8 426	7 871	9 240	10 192	10 611	12 603	12 350	12 550

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogues #26-201 and #26-202.

[1] Based on contribution in 1989 to value of mineral production.

p Preliminary

TABLE 11. CANADA, VALUE OF MINERAL PRODUCTION, 1978 AND 1988

	1978			1988^p		
	($000)	(%)	(Rank)	($000)	(%)	(Rank)
Alberta	10 087 206	49.8	1	15 061 958	40.8	1
Ontario	2 697 852	13.3	2	6 896 291	18.7	2
British Columbia	1 882 652	9.3	3	3 943 091	10.7	3
Saskatchewan	1 581 850	7.8	5	3 043 056	8.2	4
Quebec	1 796 050	8.9	4	2 711 389	7.3	5
Manitoba	459 636	2.3	7	1 626 564	4.4	6
Northwest Territories	309 639	1.5	9	956 897	2.6	7
New Brunswick	339 610	1.7	8	910 803	2.5	8
Newfoundland	675 028	3.3	6	863 748	2.3	9
Yukon	218 804	1.1	10	492 199	1.3	10
Nova Scotia	210 659	1.0	11	453 073	1.2	11
Prince Edward Island	2 068	. . .	12	2 138	. . .	12
Canada	20 261 054	100.0		36 961 207	100.0	

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogues #26-201 and #26-202.
^{p} Preliminary; . . . Amount too small to be expressed.

TABLE 11a. CANADA, VALUE OF MINERAL PRODUCTION, 1979 AND 1989

	1979			1989^p		
	($000)	(%)	(Rank)	($000)	(%)	(Rank)
Alberta	12 899 068	49.5	1	16 207 199	41.4	1
Ontario	3 264 533	12.5	2	7 308 805	18.7	2
British Columbia	2 720 552	10.4	3	4 091 222	10.5	3
Saskatchewan	1 873 772	7.2	5	3 017 193	7.7	4
Quebec	2 164 546	8.3	4	2 812 402	7.2	5
Manitoba	652 730	2.5	7	1 686 833	4.3	6
Northwest Territories	391 163	1.5	9	1 144 709	2.9	7
Newfoundland	1 124 520	4.3	6	959 213	2.5	8
New Brunswick	479 627	1.8	8	909 547	2.3	9
Yukon	299 244	1.1	10	539 880	1.4	10
Nova Scotia	209 607	0.8	11	442 638	1.1	11
Prince Edward Island	1 994	. . .	12	2 177	. . .	12
Canada	26 081 356	100.0		39 121 818	100.0	

Sources: Energy, Mines and Resources Canada; Statistics Canada, Catalogues #26-201 and #26-202.
^{p} Preliminary; . . . Amount too small to be expressed.

TABLE 12. CANADA, VALUE OF MINERAL PRODUCTION, 1988 AND 1989

	1988	1989p	Change
	($ millions)		(%)
Metals	13 607.9	14 329.0	5.3
Nonmetals	2 717.2	2 540.9	-6.5
Structural materials	2 863.2	2 890.8	1.0
Total Nonfuels	19 188.3	19 760.6	3.0
Fuels	17 772.9	19 361.2	8.9
Total	36 961.2	39 121.8	5.8

p Preliminary.
Note: Totals may not add due to rounding.

TABLE 13. CANADA, VALUE OF MINERAL PRODUCTION BY PROVINCES AND TERRITORIES, 1983–89

	1983	1984	1985	1986	1987	1988	1989^{p}
			($ million)				
Alberta	24 103	26 429	27 030	16 331	17 080	15 062	16 207
Ontario	3 687	4 531	4 630	4 825	5 651^{r}	6 896	7 309
British Columbia	2 903	3 346	3 541	3 160	3 615^{r}	3 943	4 091
Saskatchewan	2 843	3 758	3 797	2 525	3 151	3 043	3 017
Quebec	2 039	2 167	2 243	2 191	2 781	2 711	2 812
Manitoba	733	812	862	764	1 000	1 627	1 687
Northwest Territories	595	777	865	788	870^{r}	957	1 145
Newfoundland	807	979	870	817	743	864	959
New Brunswick	506	613	509	502	624^{r}	911	910
Yukon	63	70	60	176	437	492	540
Nova Scotia	260	304	321	367	407	453	443
Prince Edward Island	1	2	2	2	3	2	2
Total	38 539	43 789	44 730	32 446	36 361^{r}	36 961	39 122

^{p} Preliminary; ^{r} Revised.
Note: Totals may not add due to rounding.

TABLE 14. CANADA, PERCENTAGE CONTRIBUTION OF PROVINCES AND TERRITORIES TO TOTAL VALUE OF MINERAL PRODUCTION, 1983–89

	1983	1984	1985	1986	1987	1988	1989p
Alberta	62.5	60.4	60.4	50.3r	47.0	40.8	41.4
Ontario	9.6	10.3	10.4	14.9	15.5	18.7	18.7
British Columbia	7.5	7.6	7.9	9.7	9.9	10.7	10.5
Saskatchewan	7.4	8.6	8.5	7.8	8.7	8.2	7.7
Quebec	5.3	4.9	5.0	6.8	7.6r	7.3	7.2
Manitoba	1.9	1.9	1.9	2.4	2.8	4.4	4.3
Northwest Territories	1.5	1.8	1.9	2.4	2.4	2.6	2.9
Newfoundland	2.1	2.2	1.9	2.5	2.0	2.3	2.5
New Brunswick	1.3	1.4	1.1	1.5	1.7	2.5	2.3
Yukon	0.2	0.2	0.1	0.5	1.2	1.3	1.4
Nova Scotia	0.7	0.7	0.7	1.1	1.1	1.2	1.1
Prince Edward Island	...	...	...	...	...	...	...
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

p Preliminary; r Revised; ... Amount too small to be expressed.
Note: Totals may not add due to rounding.

TABLE 15. WESTERN WORLD PRODUCTION OF CERTAIN MAJOR METALS, 1984–88

	1984	1985	1986	1987	1988[p]
			(000 t)		
Primary Aluminum					
Europe[1]	3 814	3 642	3 716	3 748	3 805
Asia[1]	1 184	1 153	1 066	952	1 021
Africa	413	473	552	572	597
North and South America	6 367	5 946	5 787	6 388	7 028
Australia and Oceania	998	1 095	1 113	1 276	1 406
Western World Total	12 775	12 308	12 234	12 935	13 857
Lead (refined production)[2]					
Europe[1]	1 595	1 603	1 590	1 614	1 682
Asia[1]	510	541	566	583	598
Africa	126	157	145	160	167
North and South America	1 578	1 706	1 584	1 656	1 690
Australia and Oceania	226	222	175	221	185
Western World Total	4 035	4 229	4 059	4 233	4 322
Copper (refined production)					
Europe[1]	1 395	1 453	1 488	1 459	1 524
Asia[1]	1 328	1 407	1 432	1 469	1 465
Africa	1 005	992	970	987	891
North and South America	3 275	3 307	3 384	3 558	3 931
Australia and Oceania	197	194	185	208	218
Western World Total	7 200	7 353	7 458	7 681	8 029
Zinc (smelter production)					
Europe[1]	1 941	1 965	1 987	2 087	2 137
Asia[1]	940	1 004	982	1 006	1 060
Africa	221	216	197	187	174
North and South America	1 478	1 518	1 379	1 454	1 541
Australia and Oceania	302	289	303	310	299
Western World Total	4 881	4 992	4 848	5 044	5 210
Tin (smelter production)					
Europe[1]	25	26	23	23	25
Asia[1]	96	91	90	89	98
Africa	6	6	4	4	5
North and South America	42	44	42	40	56
Australia and Oceania	3	3	1	1	. . .
Western World Total	172	170	160	156	185

Source: Metallgesellschaft AG, Metallstatistik (preliminary issue) Western World 1984-1988, May 1989.

[1] Excluding Eastern countries. [2] Includes secondary lead.

[p] Preliminary; . . . Amount too small to be expressed.

Note: Totals may not add due to rounding.

TABLE 16. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1986

			Rank of Five Leading Countries				
		World	1	2	3	4	5
Uranium (U concentrates)[1]			**Canada**	U.S.A.	South Africa	Australia	Namibia
	t	37 110	11 720	5 200	4 610	4 150	3 300
	% of western world total		31.6	14.0	12.4	11.2	8.9
Zinc (mine production)			**Canada**	U.S.S.R.	Australia	Peru	China
	000 t	6 694[r]	988	970[e]	665[r]	598	396
	% of world total		14.8[r]	14.5	9.9	8.9	5.9
Gypsum			U.S.A.	**Canada**	Japan	Spain	France
	000 t	86 509	13 973	8 803	6 350[e]	5 498	4 384
	% of world total		16.2	10.2	7.3	6.4	5.1
Potash (K$_2$O equivalent)			U.S.S.R.	**Canada**	East Germany	West Germany	France
	000 t	28 551[r]	10 228	6 697	3 485	2 162	1 610
	% of world total		35.8[r]	23.5	12.2	7.6	5.6
Sulphur, elemental			U.S.A.	**Canada**	U.S.S.R.	Poland	Mexico
	000 t	36 071[r]	9 859	5 750	5 205[r]	4 900	2 054
	% of world total		27.3	15.9	14.4[r]	13.6[r]	5.7
Titanium concentrates (ilmenite)			Australia	**Canada**	Norway	U.S.S.R.	South Africa
	000 t	4 705[r]	1 252[r]	850[2,e,r]	804[r]	450[e,r]	435[3,e,r]
	% of world total		26.6[r]	18.1[r]	17.1[r]	9.6[r]	9.3[r]
Asbestos			U.S.S.R.	**Canada**	Brazil	Zimbabwe	China
	000 t	4 050	2 400[e]	662	204	164	150[e]
	% of world total		59.3	16.3	5.0	4.0	3.7
Nickel (mine production)			U.S.S.R.	**Canada**	Australia	Indonesia	New Caledonia
	000 t	786[r]	185[r]	164	77	67	65
	% of world total		23.5[r]	20.9[r]	9.8[r]	8.5[r]	8.3[r]
Platinum group metals (mine production)			South Africa	U.S.S.R.	**Canada**	Japan	Australia
	kg	258 682	123 000	120 000[e]	12 190	2 116	543
	% of world total		47.5	46.4	4.7	0.8	0.2
Aluminum (primary metal)			U.S.A.	U.S.S.R.	**Canada**	Australia	West Germany
	000 t	15 593[r]	3 037	2 350[e]	1 355	877	764
	% of world total		19.5	15.1	8.7	5.6	4.9
Molybdenum (Mo content)			U.S.A.	Chile	U.S.S.R.	**Canada**	Mexico
	t	92 667[r]	42 627	16 581	11 400	11 251[r]	3 500[e]
	% of world total		46.0	17.9	12.3	12.1	3.8
Cobalt (mine production)			Zaire	Zambia	U.S.S.R.	**Canada**	Cuba
	t	29 014[r]	14 518	4 344	2 800[e]	2 297	1 400[e]
	% of world total		50.0[r]	15.0[r]	9.7[r]	7.9[r]	4.8[r]
Cadmium (refined production)			U.S.S.R.	Japan	U.S.A.	**Canada**	Belgium
	t	19 250[r]	2 700[e]	2 489	1 486[r]	1 484	1 380
	% of world total		14.0[r]	12.9[r]	7.7[r]	7.7[r]	7.2[r]
Silver (mine production)			Mexico	Peru	U.S.S.R.	**Canada**	U.S.A.
	t	13 386[r]	2 418[r]	1 926	1 600	1 088	1 075[r]
	% of world total		18.1[r]	14.4[r]	12.0	8.1[r]	8.0
Copper (mine production)			Chile	U.S.A.	U.S.S.R.	**Canada**	Zambia
	000 t	8 461[r]	1 400	1 150[r]	1 030	699	470[r]
	% of world total		16.5[r]	13.6	12.2[r]	8.3	5.6[r]
Lead (mine production)			U.S.S.R.	Australia	U.S.A.	**Canada**	China
	000 t	3 343[r]	520[e]	418[r]	353[r]	334	226[e,r]
	% of world total		15.6[r]	12.5[r]	10.6[r]	10.0[r]	6.8[r]
Gold (mine production)			South Africa	U.S.S.R.	U.S.A.	**Canada**	China
	t	1 644[r]	640	275[e,r]	116[r]	103	78[e,r]
	% of world total		38.9[r]	16.7[r]	7.1[r]	6.3[r]	4.7[r]

[1] Total of western world [2] Titaniferous slag with 80% TiO$_2$ content [3] Titaniferous slag with 85% TiO$_2$ content

[e] Estimated, [r] Revised

TABLE 16a. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1987

		World	Rank of Five Leading Countries 1	2	3	4	5
Uranium (U concentrates)[1]	t % of western world total	36 790	**Canada** 12 440 33.8	U.S.A. 5 000 13.6	South Africa 3 960 10.8	Australia 3 780 10.3	Namibia 3 540 9.6
Zinc (mine production)	000 t % of world total	6 936	**Canada** 1 158 16.7	U.S.S.R. 950e 13.7	Australia 721 10.4	Peru 612 8.8	China 458 6.6
Gypsum	000 t % of world total	90 001	U.S.A. 14 163 15.7	**Canada** 9 094 10.1	Japan 6 532 7.3	Spain 5 534 6.1	France 4 508 5.0
Potash (K_2O equivalent)	000 t % of world total	30 008	U.S.S.R. 10 889 36.3	**Canada** 7 267 24.2	East Germany 3 510 11.7	West Germany 2 201 7.3	France 1 539 5.1
Titanium concentrates (ilmenite)	000 t % of world total	5 453	Australia 1 509 27.7	**Canada** 925[2]e 17.0	Norway 853 15.6	South Africa 650[3]e 11.9	Malaysia 509 9.3
Asbestos	000 t % of world total	4 253	U.S.S.R. 2 555e 60.1	**Canada** 665 15.6	Brazil 213 5.0	Zimbabwe 194 4.6	China 150e 3.5
Nickel (mine production)	000 t % of world total	811	U.S.S.R. 195 24.0	**Canada** 189 23.3	Australia 75 9.2	New Caledonia 58 7.2	Indonesia 57 7.0
Molybdenum (Mo content)	t % of world total	89 478	U.S.A. 34 073 38.1	Chile 16 941 18.9	**Canada** 14 771 16.5	U.S.S.R. 11 500 12.9	Mexico 4 400 4.9
Platinum group metals (mine production)	kg % of world total	266 980	South Africa 131 257 49.2	U.S.S.R. 121 000 45.3	**Canada** 10 930 4.1	Japan 2 170 0.8	Colombia 638 0.2
Sulphur, elemental	000 t % of world total	37 299	U.S.A. 9 362 25.1	U.S.S.R. 6 025 16.2	**Canada** 5 876 15.8	Poland 4 930 13.2	Mexico 2 306 6.2
Aluminum (primary metal)	000 t % of world total	16 424	U.S.A. 3 343 20.4	U.S.S.R. 2 370e 14.4	**Canada** 1 540 9.4	Australia 1 024 6.2	Brazil 844 5.1
Lead (mine production)	000 t % of world total	3 379	U.S.S.R. 510e 15.1	Australia 455 13.5	**Canada** 373 11.0	U.S.A. 318 9.4	China 267e 7.9
Cobalt (mine production)	t % of world total	27 123	Zaire 11 874 43.8	Zambia 4 479 16.5	U.S.S.R. 2 670e 9.8	**Canada** 2 490 9.2	Cuba 1 840e 6.8
Cadmium (refined production)	t % of world total	19 399	U.S.S.R. 2 600e 13.4	Japan 2 450 12.6	U.S.A. 1 515 7.8	**Canada** 1 481 7.6	Belgium 1 308 6.7
Silver (mine production)	t % of world total	13 956	Mexico 2 415 17.3	Peru 2 055 14.7	U.S.S.R. 1 550 11.1	**Canada** 1 375 9.9	U.S.A. 1 238 8.9
Copper (mine production)	000 t % of world total	8 578	Chile 1 420 16.6	U.S.A. 1 260 14.7	U.S.S.R. 1 010 11.8	**Canada** 794 9.3	Zambia 500 5.8
Gold (refined production)	t % of world total	1 738	South Africa 607 34.9	U.S.S.R. 275e 15.8	U.S.A. 155 8.9	**Canada** 116 6.7	Australia 108 6.2

[1] Total of western world [2] Titaniferous slag with 80% TiO_2 content [3] Titaniferous slag with 85% TiO_2 content

e Estimated

TABLE 16b. CANADA'S WORLD ROLE AS A PRODUCER OF CERTAIN IMPORTANT MINERALS, 1988p

		World	Rank of Five Leading Countries 1	2	3	4	5
Uranium (U concentrates)[1]			**Canada**	U.S.A.	South Africa	Namibia	Australia
	t	36 840	12 393[2]	5 190	3 850	3 600	3 530
	% of western world total		33.6	14.1	10.5	9.8	9.6
Zinc (mine production)			**Canada**	U.S.S.R.	Australia	China	Peru
	000 t	7 141	1 370	960[e]	739	527	485
	% of world total		19.2	13.4	10.3	7.4	6.8
Gypsum			U.S.A.	**Canada**	Iran	China	Japan
	000 t	96 179	14 869	9 512	8 437	8 074	6 260
	% of world total		15.5	9.9	8.8	8.4	6.5
Potash (K_2O equivalent)			U.S.S.R.	**Canada**	East Germany	West Germany	France
	000 t	31 646	11 100	8 328	3 510	2 290	1 502
	% of world total		35.1	26.3	11.1	7.2	4.7
Titanium concentrates (ilmenite)			Australia	**Canada**	Norway	South Africa	Malaysia
	000 t	5 667	1 622	1 025[3][e]	875	700[4][e]	460
	% of world total		28.6	18.1	15.4	12.4	8.1
Asbestos			U.S.S.R.	**Canada**	Brazil	Zimbabwe	China
	000 t	4 363	2 600[e]	710	230	190	150[e]
	% of world total		59.6	16.3	5.3	4.4	3.4
Nickel (mine production)			U.S.S.R.	**Canada**	New Caledonia	Australia	Indonesia
	000 t	847	205	199	69	62	60
	% of world total		24.2	23.5	8.1	7.3	7.1
Molybdenum (Mo content)			U.S.A.	Chile	**Canada**	U.S.S.R.	Mexico
	t	95 997	43 051	17 000	13 535	11 500	4 296
	% of world total		44.8	17.7	14.1	12.0	4.5
Platinum group metals (mine production)			South Africa	U.S.S.R.	**Canada**	Japan	Colombia
	kg	270 373	133 278	121 000	12 541	1 848	815
	% of world total		49.3	44.8	4.6	0.7	0.3
Sulphur, elemental			U.S.A.	U.S.S.R.	**Canada**	Poland	Mexico
	000 t	39 400	9 618	6 965	6 017	5 004	2 144
	% of world total		24.4	17.7	15.3	12.7	5.4
Aluminum (primary metal)			U.S.A.	U.S.S.R.	**Canada**	Australia	Brazil
	000 t	17 482	3 944	2 440[e]	1 535	1 141	873
	% of world total		22.6	14.0	8.8	6.5	5.0
Lead (mine production)			U.S.S.R.	Australia	**Canada**	U.S.A.	China
	000 t	3 419	520[e]	457	351	394	312[e]
	% of world total		15.2	13.4	10.3	11.5	9.1
Cobalt (mine production)			Zaire	Zambia	U.S.S.R.	**Canada**	Cuba
	t	25 826	10 139	5 025	3 000[e]	2 398	2 200[e]
	% of world total		39.3	19.5	11.6	9.3	8.5
Copper (mine production)			Chile	U.S.A.	U.S.S.R.	**Canada**	Zambia
	000 t	8 751	1 451	1 420	990	758	476
	% of world total		16.6	16.2	11.3	8.7	5.4
Cadmium (refined production)			U.S.S.R.	Japan	U.S.A.	Belgium	**Canada**
	t	21 711	2 650[e]	2 614	1 885	1 807	1 664
	% of world total		12.2	12.0	8.7	8.3	7.7
Silver (mine production)			Mexico	U.S.A.	U.S.S.R.	Peru	**Canada**
	t	14 325	2 412	1 661	1 580	1 552	1 443
	% of world total		16.8	11.6	11.0	10.8	10.1
Gold (mine production)			South Africa	U.S.S.R.	U.S.A.	Australia	**Canada**
	t	1 910	621	280[e]	205	152	135
	% of world total		32.5	14.7	10.7	8.0	7.1

[1] Total of western world [2] Does not include some 70 tU recovered by Elliot Lake Producers from refinery/conversion facility wastes [3] Titaniferous slag with 80% TiO_2 content [4] Titaniferous slag with 85% TiO_2 content

p Preliminary, e Estimated

TABLE 17. CANADA, CENSUS VALUE ADDED, TOTAL ACTIVITY, MINING AND MINERAL MANUFACTURING INDUSTRIES[1], 1981–87

	1981	1982	1983	1984	1985	1986	1987
				($ million)			
Mining							
Metallic minerals							
Nickel-copper-zinc	2 007.9	1 144.9	1 567.3	2 008.1	1 868.5	1 712.9	2 391.5
Gold	519.0	566.2	693.6	660.8	635.3	975.3	1 307.2
Uranium	610.3	600.1	496.9	772.5	813.1	802.0	898.3
Iron	1 036.0	761.4	644.6	681.4	817.1	713.8	787.2
Silver-lead-zinc	380.3	351.1	294.2	465.7	275.3	332.2	562.0
Miscellaneous metal mines	150.2	73.7	33.2	72.1	65.4	54.5	84.6
Total	4 703.7	3 497.4	3 729.8	4 660.6	4 474.7	4 590.7	6 030.8
Industrial minerals							
Potash	889.7	488.5	455.4	717.1	428.8	396.4	578.9
Stone	122.5	109.4	119.5	160.1	207.5	277.6	331.3
Sand and gravel	98.3	75.6	90.3	104.9	132.9	220.0	306.5
Miscellaneous nonmetals	171.0	183.5	201.8	240.5	226.8	289.1	267.9
Asbestos	431.5	267.3	252.7	252.7	217.6	157.1	147.6
Peat	47.8	41.1	43.0	47.1	63.0	74.6	93.5
Gypsum	31.3	26.6	35.1	40.2	50.7	56.6	67.2
Total	1 792.1	1 192.0	1 200.0	1 562.6	1 327.3	1 471.3	1 792.9
Fuels							
Petroleum and natural gas	15 924.6	18 899.8	22 171.3	25 008.2	25 428.7	15 044.3	15 843.7
Coal	671.1	838.0	911.1	1 314.2	1 264.5	1 110.4	1 136.4
Total	16 595.7	19 737.8	23 082.4	26 322.4	26 693.2	16 154.7	16 980.1
Total mining industry	23 091.5	24 427.2	28 012.2	32 545.6	32 495.2	22 216.7	24 803.8
Mineral Manufacturing							
Primary metal industries							
Primary steel	2 750.9	2 149.9	2 464.9	2 939.6	3 105.9	3 001.6	3 424.6
Smelting and refining	1 808.9	1 493.0	1 912.4	2 236.9	2 202.4	2 372.3	3 050.9
Wire and wire products industries[2]	671.7	532.9	554.6	704.2	812.9	848.8	821.0
Iron foundries	266.0	279.9	326.0	447.7	471.5	510.7	503.3
Aluminum rolling, casting and extruding	292.8	289.9	328.2	394.7	384.3	424.9	479.7
Metal rolling, casting and extruding, n.e.s.	210.4	169.2	234.1	323.1	355.2	397.1	424.9
Steel pipe and tube	378.3	320.3	213.4	389.6	388.2	331.0	385.4
Copper and alloy rolling, casting and extruding	129.3	101.6	117.7	147.8	134.7	144.0	129.6
Total[r]	6 508.3	5 336.7	6 151.3	7 583.6	7 855.0	8 030.9	9 219.5
Nonmetallic mineral products industries							
Other nonmetallic mineral products industries	483.3	426.7	487.6	571.5	672.4	781.7	924.7
Ready-mix concrete industries	430.1	388.6	405.0	397.5	455.3	626.3	748.4
Concrete products industries	378.5	349.7	333.6	376.5	463.9	522.2	590.8
Cement industries	421.4	387.4	407.5	421.9	490.7	500.2	558.4
Glass industries	364.6	339.6	403.8	460.9	466.4	482.4	532.7
Glass products industries	141.0	144.9	209.8	258.1	320.7	294.9	336.7
Clay products (domestic clay)	82.0	57.1	78.2	87.7	92.9	129.4	148.2
Abrasive industries	95.9	80.4	91.4	101.9	97.8	100.5	130.4
Clay products (imported clay)	50.9	37.9	37.2	37.3	41.4	98.6	105.2
Lime industries	62.8	60.1	66.2	75.4	70.1	78.0	87.4
Total	2 510.5	2 272.4	2 520.3	2 788.7	3 171.8	3 614.3	4 163.0

TABLE 17. (cont'd)

	1981	1982	1983	1984	1985	1986	1987
				($ million)			
Fabricated metal products industries							
Stamped and pressed metal products industries	1 447.1	1 265.1	1 303.6	1 417.2	1 612.4	1 729.2	2 069.7
Fabricated structural metal products industries	829.1	976.1	795.3	817.4	930.9	1 111.3	1 177.6
Hardware, tool and cutlery industry	714.0	653.8	650.7	786.7	932.0	993.4	1 025.5
Other metal fabricating industries	810.6	667.2	690.5	745.5	735.0	729.6	856.4
Ornamental and architectural metal products industries	622.7	529.5	491.2	519.9	608.4	722.2	813.1
Machine shop industry	449.9	444.7	451.3	549.5	611.2	636.6	692.4
Power boiler and heat exchanger industry	385.8	310.0	319.1	298.1	351.1	357.7	407.7
Heating equipment industry	206.8	188.5	182.0	162.6	243.9	262.6	269.5
Total	5 466.1	5 034.8	4 883.7	5 296.9	6 024.8	6 542.6	7 311.9
Petroleum and coal products industries							
Petroleum refining	2 641.5	2 108.4	2 563.7	2 498.2	2 478.8	1 755.6	1 860.1
Other petroleum and coal products industries	39.3	39.9	52.6	42.1	41.0	98.9	107.5
Manufacturers of lubricating oil and greases	35.0	31.7	24.8	56.1	75.7	82.5	99.0
Total	2 715.8	2 180.0	2 641.1	2 596.4	2 595.5	1 936.9	2 066.5
Total mineral manufacturing	17 200.6	14 824.0	16 196.4	18 265.6	19 647.0	20 124.7	22 760.9
Total mining and mineral manufacturing	40 292.1	39 251.2	44 208.6	50 811.2	52 142.2	42 341.4	47 564.8

[1] All years have been revised to include Fabricated Metal Products Industry. [2] Wire and wire products have been included in Stage III.
n.e.s. Not elsewhere specified; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 18. CANADA, GROSS DOMESTIC PRODUCT OF INDUSTRIAL PRODUCTION, MINING AND MINERAL MANUFACTURING AT FACTOR COST, 1981-88

(1981 = 100)	1981	1982r	1983r	1984r	1985r	1986r	1987	1988p
	($ million)							
Total industrial production	88 675.3	79 997.7	85 158.2	95 499.1	100 811.3	100 731.1	106 420.6	112 990.8
Total mining	17 453.4r	16 958.6	18 057.9	20 555.6	21 465.6	20 338.0	21 499.2	23 382.2
Metals								
Gold mines	487.0	726.4	759.9	845.9	921.8	1 098.5	1 263.5	1 452.9
Other metal mines	2 514.6	2 327.9	2 528.3	3 611.1	3 418.7	3 361.0	3 682.1	3 730.7
Iron mines	820.7	556.6	409.1	479.2	631.4	562.1	554.9	611.2
Fuels								
Crude oil and natural gas	9 786.9r	10 008.4	10 881.6	11 235.6	12 024.0	11 408.3	11 983.0	13 085.7
Nonmetals								
Asbestos	358.3	221.0	186.9	224.6	198.2	185.1	189.7	200.9
All nonmetals	751.3	531.9	635.8	824.4	718.7	724.6	763.6	854.3
Salt	71.0	77.7	86.3	106.7	104.5	125.7	121.0	125.2
Coal	466.3	491.7	576.0	920.0	939.9	834.6	908.5	1 052.5
Quarry and sand pits	314.6	246.3	278.4	321.5	369.7	445.8	545.8	595.7
Services related to mining	1 882.7	1 770.7	1 715.6	1 986.6	2 138.7	1 592.3	1 487.1	1 673.1
Mineral manufacturing								
Primary metals	5 101.0	3 832.3	4 325.4	5 289.2	5 595.5	5 424.7	5 898.8	6 322.1
Primary steel	2 378.2	1 518.8	1 863.7	2 118.0	2 183.7	2 080.4	2 241.8	2 359.1
Steel pipe and tube mills	322.4	193.2	166.6	327.8	367.4	299.7	395.0	496.1
Iron foundries	238.8	209.5	247.6	342.8	345.7	356.4	404.5	430.1
Nonferrous smelting and refining	1 610.0	1 509.7	1 599.8	1 929.6	2 068.9	2 038.7	2 192.4	2 345.0
Nonmetallic mineral products	2 015.7	1 543.9	1 710.0	1 871.7	2 042.2	2 136.3	2 278.7	2 333.3
Cement	318.5	220.6	240.5	239.5	261.6	262.5	299.3	301.4
Concrete products	311.6	257.3	245.0	267.6	322.7	342.0	380.1	438.1
Ready-mix concrete	350.8	248.2	264.3	286.7	327.3	371.3	444.8	438.3
Glass and glass products	422.0	364.8	446.9	507.8	541.0	508.7	476.5	465.3
Miscellaneous nonmetallic products	505.2	392.5	438.0	496.6	516.0	526.2	543.3	558.2
Petroleum and coal products	858.8	796.0	792.1	799.0	778.1	747.4	767.3	806.3

p Preliminary; r Revised.

TABLE 19. CANADA, GROSS DOMESTIC PRODUCT BY INDUSTRIES AT FACTOR COST, 1981-88

(1981 = 100)	1981	1982^{r}	1983^{r}	1984^{r}	1985^{r}	1986^{r}	1987	1988^{p}
				($ million)				
Gross domestic product, all industries	319 538.1^{r}	307 863.5	317 858.6	336 941.4	352 821.1	364 365.7	381 794.5	400 142.9
Agriculture	10 611.2	11 277.0	10 951.0	10 597.1	10 154.3	11 841.8	10 903.2	8 761.0
Fishing and trapping	565.3	609.9	577.7	526.4	640.6	663.9	632.2	671.4
Forestry	2 045.0	1 708.9	2 254.4	2 534.2	2 455.2	2 485.9	2 748.1	2 762.9
Mines (including milling), quarries and oil wells	17 453.4^{r}	16 958.6	18 057.9	20 555.6	21 465.6	20 338.0	21 499.2	23 382.2
Manufacturing	61 648.0^{r}	53 702.2	57 168.7	64 541.4	68 180.8	68 968.2	72 951.8	77 379.8
Construction	25 094.0^{r}	25 108.7	24 666.6	23 111.4	24 904.1	25 721.4	27 827.0	30 139.8
Transportation and storage	14 428.6	13 617.0	14 631.4	16 355.2	16 699.1	17 183.6	18 065.9	19 321.6
Communications	8 728.3	8 719.7	8 942.9	9 376.3	9 910.2	10 371.4	11 283.7	12 383.5
Electric power, gas and water utilities	8 950.3	8 666.9	9 284.5	9 758.1	10 530.2	10 788.8	11 320.4	11 555.9
Trade, wholesale	15 413.6	14 134.3	15 406.7	16 620.3	18 687.5	19 882.3	22 498.4	24 708.2
Trade, retail	19 661.3	18 973.9	19 969.0	21 147.3	22 280.9	23 231.7	24 583.7	25 780.5
Finance, insurance and real estate	44 155.3	43 087.3	44 140.4	46 977.3	49 988.9	52 835.5	55 584.8	58 205.3
Community, business and personal services	32 911.2^{r}	32 449.0	31 990.5	33 862.5	35 172.6	37 433.2	38 573.5	40 805.5
Government service	21 714.9	22 325.6	22 658.7	23 011.6	23 146.9	23 473.6	23 675.2	23 948.9

^{p} Preliminary; ^{r} Revised.

TABLE 20. CANADA, GROSS DOMESTIC PRODUCT FOR SELECTED INDUSTRIES BY PROVINCE, 1985

	Nfld.	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Sask.	Alberta	British Columbia	Yukon and N.W.T.	Canada
						($ million)						
Agriculture	26.0	93.0	155.0	139.0	1 722.0	2 918.0	1 257.0	1 952.0	1 958.0	678.0	–	10 896.0
Logging and forestry industries	57.0	3.0	81.0	190.0	594.0	508.0	35.0	32.0	112.0	992.0	1.0	2 604.0
Fishing, hunting and trapping	111.0	30.0	203.0	56.0	59.0	38.0	17.0	7.0	6.0	237.0	5.0	768.0
Mining industries[1]	475.0	1.0	209.0	99.0	862.0	2 014.0	437.0	2 343.0	18 207.0	1 534.0	550.0	26 733.0
Manufacturing industries	435.0	85.0	1 219.0	1 024.0	20 619.0	44 332.0	1 850.0	864.0	4 644.0	6 313.0	21.0	81 407.0
Construction industries	556.0	111.0	940.0	502.0	5 682.0	8 399.0	988.0	1 291.0	3 973.0	3 310.0	321.0	26 074.0
Electric power, gas and water utilities	352.0	39.0	241.0	459.0	4 310.0	4 460.0	597.0	426.0	1 745.0	1 599.0	68.0	14 296.0
Goods-producing industries	2 012.0	362.0	3 048.0	2 469.0	33 848.0	62 669.0	5 181.0	6 915.0	30 645.0	14 663.0	966.0	162 778.0

[1] Cement, lime, clay and clay products (domestic clays) industries are included under "manufacturing."

– Nil.

Note: Totals may not add due to rounding.

TABLE 21. CANADA, GROSS DOMESTIC PRODUCT FOR MINING BY PROVINCE, 1978–85

	Nfld.	Prince Edward Island	Nova Scotia	New Brunswick	Quebec	Ontario	Manitoba	Sask.	Alberta	British Columbia	Yukon and N.W.T.	Canada
						($ million)						
1978	249.2	0.1	83.1	113.7	774.5	1 255.8	190.5	855.7	5 191.2	942.8	294.6	9 951.2
1979	475.6	0.1	102.4	206.4	989.5	1 600.8	354.5	1 014.2	7 409.6	1 621.4	440.4	14 214.8
1980	445.1	0.1	116.1	96.2	1 223.1	2 476.9	428.6	1 304.4	10 033.1	1 479.5	516.7	18 119.5
1981	471.8	0.1	124.9	125.9	1 099.6	1 883.6	290.3	1 298.5	10 593.0	1 264.6	358.4	17 510.6
1982	313.0	0.1	190.0	124.5	866.5	1 356.1	282.2	1 294.3	12 531.2	1 209.7	412.8	18 580.3
1983	367.8	0.1	277.4	94.2	853.6	1 689.4	352.6	1 640.9	14 648.1	1 319.5	443.9	21 687.6
1984	484.3	0.1	260.8	191.4	779.0	2 211.4	424.1	2 437.6	16 555.4	1 701.2	492.0	25 537.4
1985	475.0	1.0	209.0	99.0	862.0	2 014.0	437.0	2 343.0	18 207.0	1 534.0	550.0	26 733.0

TABLE 22. CANADA, GROSS DOMESTIC PRODUCT FOR MINERAL MANUFACTURING INDUSTRIES BY PROVINCE, 1985

	Primary Metal Industries	Nonmetallic Mineral Products Industries	Fabricated Metal Products Industries[1]	Petroleum and Coal Products Industries	Mineral Manufacturing Industries
		($ millions)			
Newfoundland	x	15.0	8.0	x	27.0
Prince Edward Island	–	x	4.0	–	x
Nova Scotia	x	x	48.0	x	68.0
New Brunswick	x	x	37.0	x	134.0
Quebec	1 755.0	593.0	1 223.0	174.0	3 744.0
Ontario	3 365.0	1 360.0	3 565.0	243.0	8 732.0
Manitoba	63.0	68.0	121.0	x	x
Saskatchewan	x	x	49.0	x	204.0
Alberta	299.0	227.0	358.0	908.0	1 792.0
British Columbia	364.0	x	372.0	28.0	x
Yukon and Northwest Territories	–	–	–	x	x
Canada	6 107.0	2 583.0	5 785.0	1 468.0	15 943.0

[1] Fabricated Metal Products Industry has been included.

x Confidential, included in total; – Nil.

TABLE 23. CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1988

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt, sulphur, earths and stone plastering material, lime and cement	477 893	164 015	56 925	951 490	1 650 323
26	Ores, slag and ash	568 526	1 183 174	854 743	417 130	3 023 573
27	Mineral fuels, oils and products of their distillation, etc.[2]	10 151 570	138 906	1 482 482	519 041	12 291 999
28	Inorganic chemicals, compounds of precious metals, radioactive elements, etc.	1 418 145	280 487	60 786	68 894	1 828 312
31	Fertilizors	913 790	62 168	77 585	611 659	1 665 202
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	351 254	12 972	3 212	15 253	382 691
69	Ceramic products	62 392	2 471	293	9 527	74 683
70	Glass and glassware	328 820	23 441	10 340	29 290	391 891
71	Natural cultured pearls, precious stones and metals, coins, etc.	1 148 632	182 945	564 731	797 638	2 693 946
72	Iron and steel	1 739 752	129 502	20 721	152 734	2 042 709
73	Articles of iron or steel	1 672 777	44 451	4 691	142 844	1 864 763
74	Copper and articles thereof	877 965	225 353	5 807	96 099	1 205 224
75	Nickel and articles thereof	136 420	249 314	16 367	262 953	665 054
76	Aluminum and articles thereof	2 889 127	238 623	344 605	461 116	3 933 471
78	Lead and articles thereof	109 568	55 399	4 129	14 375	183 471
79	Zinc and articles thereof	594 028	45 372	25 062	108 428	772 889
80	Tin and articles thereof	6 925	51	35	814	7 825
81	Other base metals, cermets, and articles thereof	58 766	21 859	13 382	26 821	120 828
	Total	23 506 350	3 060 502	3 545 896	4 686 106	34 798 854

Source: Statistics Canada,Catalogue 65–003 (Quarterly).

[1] Harmonized System Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Value of coal exports included in Chapter 27 is $2093 million.

TABLE 24. CANADA, VALUE OF IMPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1988

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt, sulphur, earths and stone plastering material, lime and cement	333 179	29 159	3 020	101 665	467 023
26	Ores, slag and ash	363 110	41 012	8	271 165	675 295
27	Mineral fuels, oils and products of their distillation, etc.[2]	1 641 891	1 972 256	2 551	1 487 909	5 104 607
28	Inorganic chemicals, compounds of precious metals, radioactive elements, etc.	573 298	136 176	24 492	404 881	1 138 847
31	Fertilizers	196 787	26 091	381	20 083	243 342
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	196 057	93 575	4 097	17 598	311 327
69	Ceramic products	206 778	207 078	69 036	108 201	591 093
70	Glass and glassware	708 597	92 259	33 680	77 873	912 409
71	Natural/cultured pearls, precious stones and metals, coins, etc.	1 200 993	165 525	6 733	450 661	1 823 912
72	Iron and steel	873 801	707 753	101 348	663 149	2 346 051
73	Articles of iron or steel	1 697 651	305 198	240 105	401 050	2 644 004
74	Copper and articles thereof	449 837	47 883	10 682	85 009	593 411
75	Nickel and articles thereof	76 682	14 948	557	41 227	133 414
76	Aluminum and articles thereof	1 281 866	136 380	4 861	90 865	1 513 972
78	Lead and articles thereof	27 305	597	124	5 011	33 037
79	Zinc and articles thereof	20 388	3 536	243	6 805	30 974
80	Tin and articles thereof	18 884	2 237	710	25 475	47 306
81	Other base metals, cermets, and articles thereof	108 058	12 096	4 323	18 656	143 133
	Total	9 975 162	3 993 761	506 951	4 277 283	18 753 157

Source: Statistics Canada,Catalogue 65-006 (Quarterly).

[1] Harmonized System Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Value of coal imports included in Chapter 27 is $32 million.

TABLE 25. CANADA, VALUE OF EXPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1989 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt, sulphur, earths and stone plastering material, lime and cement	303 887	128 341	64 919	530 864	1 028 011
26	Ores, slag and ash	412 093	992 329	788 020	390 911	2 583 353
27	Mineral fuels, oils and products of their distillation, etc.[2]	7 775 307	119 511	1 145 022	496 028	9 535 868
28	Inorganic chemicals, compounds of precious metals, radioactive elements, etc.	1 009 126	112 201	35 346	43 997	1 200 670
31	Fertilizers	605 545	51 804	57 236	405 580	1 120 165
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	207 163	5 989	1 853	9 462	224 467
69	Ceramic products	36 594	799	296	6 906	44 595
70	Glass and glassware	251 463	19 295	3 192	17 483	291 433
71	Natural/cultured pearls, precious stones and metals, coins, etc.	918 865	132 882	258 638	700 425	2 010 810
72	Iron and steel	1 269 469	133 534	12 141	350 882	1 766 026
73	Articles of iron or steel	1 179 641	30 619	3 917	120 538	1 334 715
74	Copper and articles thereof	665 107	380 665	4 856	91 096	1 141 724
75	Nickel and articles thereof	128 983	145 393	11 067	339 187	624 630
76	Aluminum and articles thereof	2 226 358	174 927	266 387	307 916	2 975 588
78	Lead and articles thereof	32 715	29 532	3 773	28 773	94 793
79	Zinc and articles thereof	666 998	38 043	31 673	86 717	823 431
80	Tin and articles thereof	6 440	90	48	484	7 062
81	Other base metals, cermets, and articles thereof	35 230	13 719	6 834	22 827	78 610
	Total	17 730 984	2 509 673	2 695 218	3 950 076	26 885 951

Source: Statistics Canada,Catalogue 65-003 (Quarterly).

[1] Harmonized System Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Value of coal exports included in Chapter 27 is $1717 million.

TABLE 26. CANADA, VALUE OF IMPORTS OF MINERALS, METALS AND THEIR PRODUCTS FOR 1989 (9 MONTHS)

Chapter[1]	Description	United States	EEC	Japan	Other	Total
				($000)		
25	Salt, sulphur, earths and stone plastering material, lime and cement	258 196	13 987	943	69 626	342 752
26	Ores, slag and ash	283 346	90 990	0	174 249	548 585
27	Mineral fuels, oils and products of their distillation, etc.[2]	1 375 110	1 287 253	593	1 865 336	4 528 292
28	Inorganic chemicals, compounds of precious metals, radioactive elements, etc.	612 427	78 903	26 436	350 759	1 068 525
31	Fertilizers	125 385	8 528	451	3 563	137 927
68	Articles of stone, plaster, cement, asbestos, mica or similar materials	170 248	76 681	2 790	17 842	267 561
69	Ceramic products	156 443	167 227	48 010	82 877	454 557
70	Glass and glassware	552 702	72 734	24 798	61 439	711 673
71	Natural cultured pearls, precious stones and metals, coins, etc.	623 390	145 107	6 483	357 276	1 132 256
72	Iron and steel	825 724	332 134	76 471	413 584	1 647 913
73	Articles of iron or steel	1 320 008	227 727	127 326	277 570	1 952 631
74	Copper and articles thereof	369 663	34 135	8 040	107 330	519 168
75	Nickel and articles thereof	65 577	9 940	62	57 593	133 172
76	Aluminum and articles thereof	1 166 017	92 442	4 583	65 855	1 328 897
78	Lead and articles thereof	17 373	643	31	3 417	21 464
79	Zinc and articles thereof	17 242	1 014	129	4 935	23 320
80	Tin and articles thereof	12 607	2 034	247	28 964	43 852
81	Other base metals, cermets, and articles thereof	93 542	10 163	3 003	20 219	126 927
	Total	8 045 000	2 651 642	330 396	3 962 434	14 989 472

Source: Statistics Canada,Catalogue 65-003 (Quarterly).

[1] Harmonized System Chapter refers to a group of commodities covered in a specified chapter of the "Harmonized Commodity Description and Coding System", as of January 1, 1988. Canadian external trade statistics are classified according to the Harmonized System. [2] Value of coal imports included in Chapter 27 is $561 million.

TABLE 27. CANADA, APPARENT CONSUMPTION[1] OF SOME MINERALS AND RELATION TO PRODUCTION[2], 1986-88

	1986			1987			1988P		
	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production	Apparent Consumption	Production	Consumption as % of Production
	(tonnes)			(tonnes)			(tonnes)		
Quartz silica	3 620 295	2 640 436	137.1	3 450 683	2 661 903	129.6	3 229 911	2 806 775	115.1
Lime	2 099 987	2 242 577	93.6	2 210 595	2 330 071	94.9	2 427 648	2 517 982	96.4
Salt	9 157 563r	10 331 846	88.6	9 316 467	10 129 053	92.0	8 934 140	10 687 180	83.6
Cement	8 465 932	10 611 223	79.8	10 386 353	12 603 164	82.4	10 238 740	12 349 873	82.9
Gypsum	3 102 467	8 802 805	35.2	3 606 698	9 093 926	39.7	4 135 212	9 511 581	43.5
Iron ore	10 354 224	36 166 884	28.6	12 927 296	37 701 825	34.3	14 201 503	39 933 862	35.6
Potash (K_2O)	735 687	6 752 709	10.9	982 935	7 668 384	12.8	507 339	8 154 428	6.2
Asbestos	–	662 381	–	15 959	664 546	2.4	25 656	710 358	3.6

[1] "Apparent consumption" is production, plus imports, less exports. [2] "Production" refers to producers' shipments.

P Preliminary; r Revised; – Nil.

TABLE 28. CANADA, REPORTED CONSUMPTION OF MINERALS AND RELATION TO PRODUCTION, 1986-88

		1986			1987			1988		
	Unit of Measure	Consumption	Production	Consumption as % of Production	Consumption	Production	Consumption as % of Production	Consumption	Production	Consumption as % of Production
Metals										
Aluminum	t	393 270	1 355 161	29.0	421 392	1 540 439	27.4	488 097	1 534 499	31.8
Antimony	kg	539 655	3 805 138	14.2	540 147	3 705 613	14.6	107 391	3 171 482	3.4
Bismuth	kg	6 617	152 930	4.3	4 547	165 282	2.8	3 709	180 907	2.1
Cadmium	kg	17 372	1 483 907	1.2	18 919	1 481 496^r	1.3	21 988	1 663 978	1.3
Chromium (chromite)	t	20 935	–	..	18 569^r	–	..	18 537	–	..
Cobalt	kg	96 073^r	2 297 178	4.2	120 194^r	2 490 020	4.8	159 290	2 398 345	6.6
Copper^1	t	225 586^r	698 527	32.3^r	231 288^r	794 149	29.1^r	238 515	758 478	31.4
Lead^2	t	94 680	334 342	28.3	98 805^r	373 215	26.5^r	90 452	351 148	25.8
Magnesium	t	8 726^r	x	x	9 469^r	x	x	11 915	x	x
Manganese ore	t	199 699	–	..	220 053	–	..	160 146	–	..
Mercury	kg	52 076	–	..	35 714	–	..	27 364	–	..
Molybdenum (Mo content)	t	684	11 251	6.1	970^r	14 771	6.6^r	1 152	13 535	8.5
Nickel	t	8 865	163 639	5.4	9 732^r	189 086	5.1^r	9 812	198 744	4.9
Selenium	kg	14 021	353 464	4.0	14 570	430 425	3.4	13 541	321 202	4.2
Silver	kg	312 905	1 087 989	28.8	331 245	1 374 946	24.1	457 698	1 443 166	31.7
Tellurium	kg	x	20 490	..	x	13 164	x	x	19 178	x
Tin	t	3 270^r	x	x	3 780^r	x	x	3 600	x	x
Tungsten (W content)	kg	655 982^r	2 469 990	26.2	729 776^r	x	x	385 917	x	x
Zinc	t	126 115	988 173	12.8	131 659^r	1 157 936	11.4^r	151 105	1 370 000	11.0
Nonmetals										
Barite	t	22 833^r	40 335	56.6^r	15 832	42 103	37.6	22 632	51 450	44.0
Feldspar	t	2 248	–	..	2 340	–	..	2 574	–	..
Fluorspar	t	147 077	x	x	179 595	x	x	179 193	x	x
Mica	kg	3 249	x	x	4 791	x	x	4 107	x	x
Nepheline syenite	t	94 404	467 491	20.2	99 651	506 415	19.7	91 008	539 835	16.9
Phosphate rock	t	2 356 892	–	..	2 062 710	–	..	2 027 850	–	..
Potash (K_2O)	t	315 975	6 752 709	4.7	288 977	7 668 384	3.8	221 881	8 154 428	2.7
Sodium sulphate	t	228 360	370 726	61.6	188 626	342 076	55.1	187 838	330 971	56.8
Sulphur	t	1 094 047^r	7 724 006	14.2	986 443	6 531 940	15.1	1 145 284	6 837 991	16.7
Talc, etc	t	65 234^r	123 037	53.0^r	65 953	136 418	48.3	70 584	146 493	48.2
Fuels										
Coal	000 t	44 558	57 811	77.1	50 144	61 212	81.9	54 390	70 644	77.0
Natural gas^3	million m^3	48 084	71 896	66.9	45 997	78 267	58.8	46 000	90 911	50.6
Crude oil^4	000 m^3	78 205	85 468	91.5	81 811	89 140	91.8	85 972	93 806	91.6

[1] Consumption defined as Anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and matte. [2] Consumption includes primary and secondary refined metal. [3] Consumption defined as domestic sales. [4] Consumption defined as refinery receipts.
^{r} Revised; – Nil; .. Not applicable; x Confidential.
Note: Unless otherwise stated, consumption refers to reported consumption of refined metals or nonmetallic minerals by consumers. Production of metals, in most cases, refers to production in all forms, and includes the recoverable content of ores, concentrates, matte, etc., and metal content of primary products recoverable at domestic smelters and refineries. Production of nonmetals refers to producers' shipments. For fuels, production is equivalent to actual output less waste.

TABLE 29. CANADA, DOMESTIC CONSUMPTION OF PRINCIPAL REFINED METALS IN RELATION TO REFINERY PRODUCTION[1], 1982-88

	Unit of Measure	1982	1983	1984	1985	1986	1987	1988
Aluminum								
Domestic consumption[2]	t	273 523	332 389	379 249	346 033	393 270	421 392	488 097
Production	t	1 064 795	1 091 213	1 221 985	1 282 316	1 355 161	1 540 439	1 534 499
Consumption of production	%	25.7	30.5	31.0	27.0	29.0	27.4	31.8
Copper								
Domestic consumption[3]	t	130 559	170 443	231 039[r]	222 466[r]	225 586[r]	231 288[r]	238 515
Production	t	337 780	464 333	504 262	499 626	493 445	491 124[r]	528 723
Consumption of production	%	38.7	36.7	45.8[r]	44.5[r]	45.7[r]	47.1[r]	45.1
Lead								
Domestic consumption[4]	t	103 056	88 579	111 642	104 447	94 680	98 805[r]	90 452
Production	t	174 310	178 043	174 987	173 220	169 934	139 475[r]	179 461
Consumption of production	%	59.1	49.8	63.8	60.3	55.7	70.8[r]	50.4
Zinc								
Domestic consumption[4]	t	100 233	116 257	119 573	123 256	126 115	131 659[r]	151 105
Production	t	511 870	617 033	682 976	692 406	570 981	609 909[r]	670 333
Consumption of production	%	19.6	18.8	17.5	17.8	22.1	21.6[r]	22.5

[1] Production of refined metal from all sources, including metal derived from secondary materials at primary refineries. [2] Consumption of primary refined metal, reported by consumers. [3] Consumption defined as Anode copper recovered in Canada from domestic concentrate plus exports of payable copper in concentrates and mattes. [4] Consumption of primary and secondary refined metal, reported by consumers.

[r] Revised.

TABLE 30. AVERAGE ANNUAL PRICES[1] OF SELECTED MINERALS, 1982–88

	Unit of Measure	1982	1983	1984	1985	1986	1987	1988
Aluminum, London Metal Exchange	¢/lb	44 966	65 342	56 526	47 850	52 179	71 004	115 394
Antimony, New York dealer	$/lb	1 072	0 913	1 512	1 311	1 219	1 116	1 039
Asbestos, No 4T cement fibre	C$/t	876 000	1 083 000	1 083 000	1 083 000	1 083 000	1 083 000	1 080 000
Bismuth, New York dealer	$/lb	1 533	1 653	4 132	4 932	3 017	3 629	5 726
Cadmium, New York dealer[2]	$/lb	1 113	1 129	1 693	1 208	1 248	1 768	7 031
Calcium, metal crowns (Producer Price List)	$/lb	3 050	3 050	3 099	3 504	3 920	3 850	3 850
Chrome, U S metal, 9% carbon	$/lb	4 450	4 450	4 450	4 450	3 021	2 700	2 700
Cobalt, metal, shot/cathode/250 kg	$/lb	12 500	12 500	12 417	11 700	11 242	7 000	7 532
Columbium, pyrochlore	$/lb	3 250	3 250	3 250	3 209	2 600	3 250	2 600
Copper, electrolytic cathode, COMEX	¢/lb	65 820	71 902	61 320	60 988	61 649	77 837	119 183
Gold, London[3]	C$/troy oz	465 102	520 792	466 781	433 227	510 628	592 011	538 024
Iridium, Impala producer	$/troy oz	600 000	600 000	600 000	600 000	600 000	513 750	420 000
Iron ore, taconite pellets	¢/ltu	80 500	80 500	80 500	80 500	80 500	77 548	72 441
Lead, producer	C¢/lb	32 887	26 770	33 517	26 179	30 885	47 985	46 013
Magnesium, U S primary ingot (Producer Price List)	$/lb	1 340	1 365	1 455	1 480	1 530	1 530	1 563
Manganese, U S metal, regular	¢/lb	86 274	67 583	73 542	80 000	79 450	80 687	86 417
Mercury, New York dealer	$/flask (76 lb)	370 934	322 443	314 381	310 957	232 785	295 503	335 517
Molybdenum, dealer, oxide	$/lb	4 100	3 635	3 557	3 247	2 871	2 899	3 449
Nickel, New York dealer, cathode	$/lb	2 320r	2 180r	2 221r	2 260r	1 855r	2 278r	6 122
Osmium, New York dealer	$/troy oz	130 000	133 113	466 479	913 125	698 854	632 458	588 750
Palladium, Impala producer	$/troy oz	110 000	130 000	146 667	126 905	130 595	150 000	150 000
Platinum, Impala producer	$/troy oz	475 000	475 000	475 000	475 000	519 147	600 000	600 000
Potash, coarse, major producer, 60% contained, K_2O[4]	$/st	72 480	71 500	65 000	55 729	46 750	68 000	86 000
Rhodium, Impala producer	$/troy oz	600 000	600 000	627 500	892 708	1 194 583	1 240 000	1 275 000
Ruthenium, New York dealer	$/troy oz	25 615	28 529	104 183	100 269	73 423	69 796	62 204
Selenium, New York dealer	$/lb	3 766	3 722	8 995	7 248	5 596	6 479	10 085
Silver, Handy & Harman, Toronto	C$/troy oz	9 831	14 154	10 828	8 674	7 862	9 593	8 043
Sulphur, elemental, North American deliveries	C$/t	68 300	60 170	69 222	100 775	107 959	88 234	71 050
Tantalum, tantalite ore, spot	$/lb	31 540	23 146	29 438	26 292	18 008	20 542	37 700
Tellurium, major producer, slab	$/lb	10 000	9 000	11 000	11 000	10 000	10 006	14 250e
Tin, New York dealer	$/lb	5 869	6 013	5 678	5 279r	2 941	3 156	3 309
Titanium, slag	$/lt	150 000	150 000	150 000	150 000	150 000	150 000	215 838
Tungsten, London Metal Bulletin - ore	$/mtu	103 992	79 029	79 146	64 925	42 554	44 492	52 015
Uranium, U_3O_8[5]	C$/lb	44 234	38 500	34 600	35 380	34 000	30 000	30 000
Vanadium, pentoxide, metallurgical	$/lb	3 350	3 350	3 350	3 350	3 350	3 350	3 350
Zinc, special high grade	C¢/lb	49 167	52 632	63 823	56 876	55 129	57 794	74 988

Sources Alberta Energy Resource Industries Monthly Statistics, Engineering and Mining Journal, "Metals Week", Northern Miner, Mineral Commodity Summaries

[1] Prices, except where noted, are in United States currency [2] 1982–86 U S producer price, 1987 and 1988 New York dealer price [3] Average afternoon fixings of London bullion dealers, converted to Canadian dollars [4] Annual average not available, indicative price given [5] From EMR publications on assessment of Canada's uranium supply and demand

r Revised, e Estimated

TABLE 31. CANADIAN AVERAGE ANNUAL PRICES OF SELECTED MINERALS, 1982–88

	Unit of Measure	1982	1983	1984	1985	1986	1987	1988
Aluminum, London Metal Exchange	$/kg	1 223	1 775	1 614	1 440	1 598	2 076[r]	3 131
Antimony, New York dealer	$/kg	2 917	2 481	4 316	3 947	3 734	3 262	2 819
Asbestos, No 4T cement fibre	$/t	876 000[r]	1 083 000[r]	1 083 000[r]	1 083 000	1 083 000	1 083 000	1 080 000
Bismuth, New York dealer	$/kg	4 171	4 491	11 795	14 847	9 241	10 609	15 538
Cadmium, New York dealer[1]	$/kg	3 028	3 067	4 833	3 637	3 823	5 812	19 079
Calcium, metal crowns (Producer Price List)	$/kg	8 298	8 286	8 846	10 549	12 008	11 255	10 447
Chrome, U S metal, 9% carbon	$/kg	12 107	12 090	12 703	13 396	9 253	7 893	7 327
Cobalt, metal, shot/cathode/250 kg	$/kg	34 009	33 961	35 446	35 222	34 436	20 463	20 439
Columbium, pyrochlore	$/kg	8 842	8 830	9 278	9 660	7 964	9 501	7 055
Copper, electrolytic cathode, COMEX	$/kg	1 791	1 953	1 750	1 836	1 888	2 275	3 234
Gold, London[2]	$/g	14 953	16 744	15 007	13 929	16 417	19 034	17 298
Iridium, Impala producer	$/g	23 806	23 773	24 978	26 341	26 802	21 902	16 621
Iron ore, taconite pellets	¢/mtu	97 776	97 638	102 588	108 187	110 082	101 204	87 757
Lead, producer	¢/kg	72 503	59 018	73 892	57 715	68 090	105 789	101 441
Magnesium, U S primary ingot (Producer Price List)	$/kg	3 646	3 709	4 153	4 455	4 687	4 473	4 241
Manganese, U S metal, regular	$/kg	2 347	1 836	2 099	2 408	2 434	2 359	2 345
Mercury, New York dealer	$/kg	13 279	11 527	11 808	12 317	9 382	11 366	11 980
Molybdenum, dealer, oxide	$/kg	11 155	9 876	10 154	9 775	8 794	8 475	9 359
Nickel, New York dealer, cathode	$/kg	6 334[r]	5 923[r]	6 340[r]	6 804[r]	5 682[r]	6 659[r]	16 613
Osmium, New York dealer	$/g	5 158	5 274	19 419	40 088	31 218	26 963	23 299
Palladium, Impala producer	$/g	4 364	5 151	6 106	5 571	5 834	6 395	5 936
Platinum, Impala producer	$/g	18 847	18 820	19 774	20 853	23 191	25 579	23 744
Potash, coarse, major producer, 60% contained, K_2O[3]	$/t	98 599	97 128	92 775	83 884	71 601	99 392[r]	116 685
Rhodium, Impala producer	$/g	23 806	23 773	26 123	39 192	53 363	52 863	2 462
Ruthenium, New York dealer	$/g	1 016	1 130	4 337	4 402	3 280	2 976	2 462
Selenium, New York dealer	$/kg	10 246	10 112	25 677	21 820	17 141	18 940	21 826
Silver, Handy & Harman, Toronto	$/kg	316 074	455 062	348 128[r]	278 876[r]	252 769	308 422	258 595
Sulphur, elemental, North American deliveries	$/t	68 300	60 170	69 222	100 775	107 959	88 234	71 050
Tantalum, tantalite ore, spot	$/kg	85 811	62 885	84 034	79 150	55 161	60 050	102 302
Tellurium, major producer, slab	$/kg	27 207	24 452	31 401	33 115	30 631	29 250	38 669
Tin, New York dealer	$/kg	15 968	16 337	16 209	15 892[r]	9 009	9 226	8 979
Titanium, slag	$/t	182 191	181 933	191 158[r]	201 591	205 121	195 757	261 472
Tungsten, London Metal Bulletin - ore	$/mtu	128 336	97 392	102 481	88 656	59 125	58 996	64 024
Uranium, U[4]	$/kg	115 000	100 000	90 000	92 000	89 000	79 000	110 000
Vanadium, pentoxide, metallurgical	$/kg	9 114	9 102	9 563	10 085[r]	10 262[r]	9 793[r]	9 091
Zinc, special high grade	$/kg	1 084	1 160	1 407	1 254	1 215	1 274	1 653

Sources: Alberta Energy Resource Industries Monthly Statistics; Engineering and Mining Journal; "Metals Week;" Northern Miner; Mineral Commodity Summaries

[1] 1982-86 U S producer price; 1987 and 1988 New York dealer price [2] Average afternoon fixings of London bullion dealers, converted to Canadian dollars [3] Annual average not available, indicative price given [4] From EMR publications on assessment of Canada's uranium supply and demand

[r] Revised

TABLE 32. CANADA, MINERAL PRODUCTS INDUSTRIES, SELLING PRICE INDEXES,1982–88

Base (1981 = 100)	1982	1983	1984	1985	1986	1987	1988^p
Iron and steel products industries							
Ferro-alloy and steel foundries	104.3	104.1	110.5	113.3	114.7	113.3	116.8
Iron foundries	107.4	109.0	112.2	116.6	119.8	121.9	125.8
Primary steel industries	108.7	109.9	113.5	115.7	116.9	118.4	125.2
Steel pipe and tube mills	109.8	108.9	111.0	112.1	112.4	113.0	119.2
Nonferrous primary metal products industries							
Aluminum rolling, casting and extruding	99.9	103.6	116.2	111.2	114.4	117.7	137.9
Copper and alloy, rolling, casting and extruding	93.4	99.2	91.4	93.0	95.9	108.6	144.2
Jewellery and silverware manufacturers	88.6	99.9	90.6	87.7	94.9	99.9	94.6
Metal rolling, casting and extruding, n.e.s.	96.6	99.7	106.6	100.9	102.3	108.6	125.7
Nonferrous metal smelting and refining industries	90.6	95.6	98.1	91.7	95.2	106.5	143.9
Nonmetallic mineral products industries							
Agricultural chemicals industries	102.5	100.2	103.8	104.2	101.7	102.1	108.6
Cement industries	117.9	123.7	128.0	133.9	137.3	138.4	139.9
Clay products from domestic clay	112.8	120.5	130.7	143.0	152.6	164.4	169.5
Clay products from imported clay	110.4	115.5	118.1	121.5	128.1	135.2	142.3
Concrete products	111.2	115.0	113.8	114.0	120.5	126.5	136.3
Glass and glass products	109.4	114.5	119.0	121.1	126.0	131.0	138.0
Nonmetallic mineral insulating materials industries	110.6	112.7	113.4	120.8	121.8	127.3	133.3
Refined petroleum and coal products industries	115.7	121.8	127.1	133.5	107.2	101.9	95.3
Fabricated metal products industries							
Agricultural implements industry	112.5	119.7	125.3	130.3	133.3	135.7	137.8
Fabricated structural metal products	107.8	108.5	110.8	115.3	118.0	120.6	128.2
Hardware, tool and cutlery manufacturers	111.6	115.7	121.6	128.0	132.5	137.5	144.9
Heating equipment manufacturers	111.6	117.5	121.9	127.2	129.6	132.9	137.9
Other metal fabricating industries	107.1	109.5	114.6	119.1	123.5	126.5	137.9
Power boiler and heat exchanger industry	106.0	110.7	114.2	120.0	130.0	141.5	149.2
Stamped, pressed and coated metal products	107.1	112.5	115.8	118.4	123.2	127.1	131.6
Wire and wire products manufacturers	106.7	107.2	113.0	115.5	116.4	118.1	124.2

^{p} Preliminary; n.e.s. Not elsewhere specified.

TABLE 33. CANADA, SELLING PRICE INDEXES OF MINERAL RAW MATERIALS,1982–88

Base (1981 = 100)	1982	1983	1984	1985	1986	1987	1988ᵖ
Metallic materials							
Copper concentrates	88.0	92.4	80.8	86.6	89.5	106.3	142.1
Iron ore	103.5	105.2	109.5	114.0	115.5	111.4	105.2
Lead concentrates	70.6	57.5	73.1	56.7	67.7	106.2	102.8
Nickel concentrates	91.3	84.5	92.8	99.4	87.2	97.0	229.7
Other base metals, n.e.s	90.5	95.3	104.8	94.8	96.8	103.6	126.1
Precious metals	82.5	99.0	84.9	77.2	86.6	99.2	90.0
Gold ingots	83.1	98.0	85.0	78.2	88.1	100.5	91.5
Platinum	76.5	99.6	87.5	74.1	119.3	139.0	63.5
Silver	75.4	111.2	82.1	65.8	59.8	72.9	121.4
Radioactive concentrates	110.3	98.5	95.1	91.9	91.1	89.2	80.1
Zinc concentrates	89.9	96.3	118.4	105.0	101.7	108.0	141.0
Nonmetal materials							
Asbestos	100.7	110.9	110.4	108.0	107.7	107.8	108.7
Other nonmetallic materials, n.e.s.	110.5	110.1	114.3	116.0	117.5	117.8	123.0
Potash (muriate)	104.6	91.8	99.5	93.5	92.0	99.0	133.7
Sand and gravel	109.2	108.8	108.2	109.4	112.1	117.3	128.0
Silica sand	110.5	117.2	114.6	118.4	122.1	122.6	131.4
Stone	112.8	123.6	127.5	133.8	138.9	143.4	149.8
- building	112.0	123.2	127.6	132.9	136.5	141.3	145.3
- crushed	114.9	127.6	134.6	143.3	151.0	157.3	164.7
- other	112.0	123.2	127.6	132.9	136.5	141.3	145.3
Sulphur	112.8	98.9	114.4	167.2	179.1	145.9	117.9
Mineral fuels							
Coal, thermal	110.3	111.0	118.6	119.5	119.3	120.2	107.0
Natural gas	127.6	134.3	131.4	131.6	129.2	124.9	115.1
Oil, crude	120.6	130.0	131.8	138.9	80.1	88.6	69.0

ᵖ Preliminary; n.e.s. Not elsewhere specified.

TABLE 34. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1], 1987

	Mining Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Metals											
Nickel–copper–zinc	25	14 080	31 013	523 140	213 808	1 551 212	4 156 511	2 391 491	18 979	736 910	2 391 483
Gold	51	7 598	16 612	299 136	82 271	421 584	1 815 583	1 311 727	9 757	388 846	1 307 237
Uranium	5	4 393	9 172	185 314	51 401	158 321	1 109 774	900 053	5 289	228 190	898 262
Iron	7	4 319	9 362	171 108	170 958	374 037	1 331 045	786 050	6 039	246 047	787 184
Silver–lead–zinc	14	3 169	7 072	124 145	65 689	591 815	1 225 927	568 423	4 372	181 320	561 993
Miscellaneous metal mines[3]	6	770	1 656	24 276	10 874	42 373	138 522	85 275	1 060	35 415	84 629
Total	108	34 329	74 887	1 327 119	595 001	3 139 342	9 777 362	6 043 019	45 496	1 816 728	6 030 788
Industrials											
Potash	11	3 050	6 599	103 935	98 264	100 334	774 445	575 846	4 094	148 503	578 933
Stone	127	2 244	5 167	69 719	32 926	106 601	458 409	318 882	2 911	91 830	331 308
Sand and gravel	138	1 597	3 679	49 436	27 063	86 967	375 192	261 162	2 827	92 044	306 504
Miscellaneous nonmetals[4]	53	2 001	4 502	66 476	31 495	55 357	357 094	270 242	2 790	96 084	267 860
Asbestos	4	2 185	4 511	69 797	33 248	62 506	238 775	143 021	2 858	97 928	147 621
Peat	59	1 255	2 809	24 472	5 319	22 512	113 865	86 034	1 510	31 518	93 548
Gypsum	10	657	1 549	17 790	6 434	19 695	86 511	60 383	929	27 698	67 175
Total	402	12 989	28 816	401 625	234 749	453 972	2 404 291	1 715 570	17 919	585 605	1 792 949
Fuels											
Coal	28	8 458	17 242	350 972	109 014	303 112	1 547 994	1 135 868	10 406	448 055	1 136 383
Oil, crude and natural gas	738	8 563	17 220	352 981	295 041	973 723	16 922 699	15 653 935	33 691	1 596 005	15 843 719
Total	766	17 021	34 462	703 953	404 055	1 276 835	18 470 693	16 789 803	44 097	2 044 060	16 980 102
Total mineral industry	1 276	64 339	138 165	2 432 697	1 233 805	4 870 149	30 652 346	24 548 392	107 512	4 446 393	24 803 839

[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Total activity includes sales and head offices.
[3] Includes molybdenum. [4] Includes salt.
Note: Totals may not add due to rounding.

TABLE 35. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES, 1986

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Primary Metal Industries											
Primary steel	58	35 193	76 001	1 258 271	501 083	4 161 518	7 753 946	2 990 359	46 461	1 732 803	3 001 589
Smelting and refining	34	20 233	40 523	720 306	408 615	1 892 980	4 744 013	2 379 504	29 058	1 115 267	2 372 789
Wire and wire products industries[2]	331	11 886	24 969	291 528	40 678	970 957	1 832 669	822 648	15 262	400 766	848 825
Iron foundries	100	6 345	13 803	181 646	40 890	269 340	812 837	510 255	7 547	228 419	510 681
Aluminum rolling, casting and extruding	71	4 938	10 893	153 133	37 571	946 194	1 399 970	425 073	6 200	205 352	424 927
Metal rolling, casting and extruding, n e s	104	5 251	11 595	139 859	28 527	471 775	891 139	397 298	6 357	178 595	397 072
Steel pipe and tube	38	3 563	7 857	113 820	18 982	622 518	985 473	329 316	4 829	162 693	330 955
Copper and alloy rolling, casting and extruding	38	2 626	5 473	66 423	14 414	357 731	521 587	147 486	3 059	83 378	144 012
Total[1]	774	90 035	191 114	2 924 986	1 090 760	9 693 013	18 941 634	8 001 939	118 773	4 107 273	8 030 850
Nonmetallic Mineral Products Industries											
Ready mix concrete	595	8 779	18 414	241 196	53 971	825 897	1 488 664	609 609	10 422	294 410	626 340
Cement	24	2 205	4 919	85 531	160 698	173 174	831 734	495 505	3 514	136 166	500 220
Primary glass and glass containers	18	5 863	12 329	171 527	65 064	190 242	736 912	482 326	7 722	241 583	482 438
Glass products	165	4 852	9 890	117 548	15 346	324 266	632 933	290 805	5 726	147 903	294 876
Gypsum products	28	1 568	3 367	44 545	37 801	212 318	522 556	272 930	2 195	65 837	283 901
Mineral insulating products	46	2 181	4 680	62 477	33 687	153 706	353 846	165 289	3 464	109 231	237 702
Other concrete products	297	4 252	8 738	89 540	15 834	182 752	426 955	230 798	4 771	109 125	235 853
Structural concrete products	61	2 187	4 684	60 506	5 728	102 286	274 693	165 569	2 697	79 150	164 283
Clay products (domestic)	36	1 210	2 642	32 359	28 940	26 311	182 007	124 777	1 605	46 710	129 418
Other nonmetallic mineral products	155	2 113	4 315	43 653	9 774	86 245	210 580	117 260	2 447	54 272	124 530
Concrete pipe	51	1 402	2 994	36 203	5 923	81 782	211 158	121 680	1 706	48 621	122 022
Abrasives	30	1 347	2 724	33 943	32 342	99 694	227 745	96 953	1 827	50 563	100 513
Refractory products	25	1 035	2 175	26 836	8 080	79 390	179 184	93 707	1 616	44 820	99 872
Clay products (imported)	56	1 806	3 737	40 066	8 380	41 410	147 035	97 288	2 165	49 930	98 625
Lime	14	593	1 271	20 773	42 532	24 567	144 365	76 755	778	28 081	78 025
Asbestos products industry[1]	12	618	1 276	14 757	2 548	26 636	61 644	30 861	835	21 485	35 654
Total[1]	1 613	42 011	88 155	1 121 460	526 648	2 630 676	6 632 011	3 472 112	53 490	1 527 887	3 614 272

TABLE 35. (cont'd)

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Fabricated Metal Products Industries											
Stamped and pressed metal products industries	983	25 765	54 647	589 195	69 379	2 782 148	4 504 885	1 678 961	31 584	790 332	1 729 180
Fabricated structural metal products industries	415	15 229	31 880	390 012	27 363	949 990	2 040 980	1 080 636	19 213	518 044[r]	1 111 347
Hardware, tool and cutlery industry	913	18 282	38 682	435 083	20 324	569 226	1 538 296	961 056	21 164	529 986	993 378
Other metal fabricating industries	536	12 270	25 803	277 264	30 850	706 299	1 432 641	706 519	15 170	371 922[r]	729 598
Ornamental and architectural metal products industries	790	14 314	30 265	295 982	18 883	799 284	1 527 796	715 849	17 462	392 502	722 209
Machine shop industry	1 475	16 319	33 820	363 226	16 694	428 340	1 074 230	630 449	17 259	394 824	636 621
Power boiler and heat exchanger industry	42	3 065	6 448	81 367	4 398	177 623	540 845	350 480	4 990	144 659	357 657
Heating equipment industry	174	4 390	9 248	86 168	5 223	271 588	531 958	258 746	5 779	122 069	262 637
Total[r]	5 328	109 634	230 793	2 518 297	193 114	6 684 498	13 191 631	6 382 696	132 621	3 264 338	6 542 627
Petroleum and Coal Products Industries											
Petroleum refining products	31	5 227	11 673	232 528	269 509[r]	12 395 312	15 145 368	1 752 822[r]	13 287	608 418	1 755 615[r]
Other petroleum and coal products	60	529	1104	14 179	10 539	195 098	315 959	98 786	778	23 840	98 856
Lubricating oils and greases	35	603	1 345	18 449	5 575	207 881	295 038	80 109	1 001	31 742	82 467
Total	126	6 359	14 122	265 156	285 623[r]	12 798 291	15 756 365	1 931 717[r]	15 066	664 420	1 936 938[r]
Total, mineral manufacturing industries[r]	7 841	248 039	524 184	6 829 899	2 096 145	31 806 478	54 521 641	19 788 464	319 950	9 563 918	20 124 687

[1] Total activity includes sales and head offices [2] Wire and wire products have been included in Stage III
n.e.s. Not elsewhere specified, [r] Revised
Note Totals may not add due to rounding

TABLE 35a. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES, 1987

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Primary Metal Industries											
Primary steel	60	..	..	..	485 392	4 456 810	8 415 637	..	46 493	1 793 886	3 424 603
Smelting and refining	34	20 654	..	756 156	446 242	2 152 673	5 673 560	3 028 517	29 397	1 149 582	3 050 899
Wire and wire products industries[2]	302	..	..	..	39 415	1 150 215	2 001 941	..	15 284	406 338	821 019
Aluminum rolling, casting and extruding	71	..		..	33 449	1 169 431	1 701 916	..	6 143	215 473	503 334
Iron foundries	91	..		..	44 175	347 018	871 450	..	7 860	242 477	479 674
Metal rolling, casting and extruding, n.e.s.	96	..	..	..	28 304	547 807	1 005 297	..	6 414	183 586	424 895
Steel pipe and tube	36	..	..	..	22 260	806 033	1 233 548	..	4 967	170 371	385 442
Copper and alloy rolling, casting and extruding	39	..	..	..	15 298	466 060	607 483	..	2 828	83 237	129 629
Total	729	..	..	..	1 114 535	11 096 047	21 510 832	..	119 386	4 244 950	9 219 495
Nonmetallic Mineral Products Industries											
Ready-mix concrete	587	10 124	..	284 846	59 474	1 002 291	1 791 627	730 174	11 910	343 436	748 359
Cement	24	2 294	..	87 173	162 830	196 479	918 182	546 169	3 646	143 154	558 446
Primary glass and glass containers	23	5 751	..	171 795	60 477	199 084	792 880	531 144	7 584	244 603	532 673
Glass products	153	5 162	..	131 212	14 876	300 805	639 869	327 418	6 021	161 356	336 724
Gypsum products	30	1 667	..	49 873	33 881	245 151	587 088	309 680	2 375	74 702	322 746
Mineral insulating products	43	2 228	..	67 089	35 562	168 967	391 692	188 780	3 444	117 067	316 997
Other concrete products	248	4 880	..	107 529	15 918	192 952	485 128	282 644	5 403	129 528	292 084
Structural concrete products	64	2 496	.	70 160	5 155	131 590	304 764	1 365 819	3 006	87 788	164 719
Clay products (domestic)	34	1 250		35 020	26 293	28 141	197 402	143 341	1 738	54 457	148 230
Other nonmetallic mineral products	153	2 384	..	53 719	10 638	105 205	249 193	136 147	2 707	64 298	144 926
Concrete pipe	50	1 581	..	42 939	5 970	95 053	231 241	133 127	1 900	56 655	133 996
Clay products (imported)	56	1 700	..	38 691	7 558	45 459	180 614	128 400	2 192	52 927	130 436
Refractory products	29	1 291	..	31 462	7 019	106 747	224 344	109 285	1 772	47 055	116 741
Abrasives	29	1 265	..	32 494	34 589	102 918	244 146	102 183	1 693	48 326	105 199
Lime	14	595	..	20 803	38 470	29 448	153 649	86 904	784	28 587	87 421
Asbestos products industry	10	490	..	10 137	2 037	26 341	52 594	23 151	647	14 929	23 326
Total	1 547	45 158	..	1 234 942	520 747	2 976 631	7 444 413	5 144 366	56 822	1 668 868	4 163 023

TABLE 35a. (cont'd)

	Mineral Manufacturing Activity								Total Activity[1]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Fabricated Metal Products Industries											
Stamped and pressed metal products industries	971	..	..	..	75 267	3 470 056	5 610 044	..	35 321	887 398	2 069 735
Fabricated structural metal products industries	396	..	..	..	28 878	1 263 621	2 477 554	..	18 615	501 785	1 117 608
Hardware, tool and cutlery industry	855	..	..	..	24 738	747 123	1 794 817	..	22 129	573 057	1 025 466
Other metal fabricating industries	538	..	..	..	31 554	913 311	1 786 377	..	16 358	418 340	856 434
Ornamental and architectural metal products industries	766	..	..	..	22 700	1 008 568	1 836 938	..	19 770	446 010	813 080
Machine shop industry	1 464	..	..	..	19 254	483 560	1 194 506	..	18 398	436 311	692 422
Power boiler and heat exchanger industry	43	..	..	..	4 715	240 407	662 833	..	4 816	148 645	407 658
Heating equipment industry	163	..	..	..	5 636	317 251	595 940	..	6 252	136 408	269 497
Total	5 196	..	..	..	212 742	8 443 897	15 959 009	..	141 659	3 547 954	7 311 900
Petroleum and Coal Products Industries											
Petroleum refining products	30	..	..	..	290 139	15 018 518	6 958 489	..	13 252	647 779	1 860 061
Other petroleum and coal products	62	..	..	..	12 290	260 099	376 200	..	894	28 053	107 478
Lubricating oils and greases	34	..	..	..	5 052	245 136	347 950	..	1 002	32 476	98 976
Total	126	..	..	..	307 481	15 523 753	17 682 279	..	15 148	708 308	2 066 515
Total, mineral manufacturing industries[2]	7 598	..	..	..	2 155 505	38 040 328	62 596 533	..	333 015	10 170 080	22 760 933

[1] Total activity includes sales and head offices. [2] Wire and wire products have been included in Stage III.
p Preliminary; n.e.s. Not elsewhere specified; .. Not available.
Note: Totals may not add due to rounding.

TABLE 36. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY[1] BY REGION, 1987

	Mines, Quarries and Oil Well Activity										
		Production and Related Workers			Costs				Total Activity[2]		
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Atlantic Provinces[3]	98	7 605	15 973	247 599	125 248	514 748	1 430 293	790 297	9 827	335 890	793 091
Quebec	187	10 143	22 122	366 103	179 563	618 844	2 075 294	1 276 887	13 919	522 481	1 284 944
Ontario	164	17 676	39 352	655 299	217 992	1 270 706	4 461 985	2 973 287	24 157	928 336	3 029 158
Prairie Provinces	609	17 157	35 220	655 422	466 664	1 420 593	18 533 898	16 646 641	44 371	1 970 651	16 802 623
British Columbia[4]	179	9 830	20 807	417 483	187 182	769 092	3 096 038	2 139 764	12 229	545 190	2 150 333
Yukon and Northwest Territories[5]	39	1 928	4 692	90 792	57 155	276 168	1 054 840	721 516	3 009	143 845	743 691
Canada	1 276	64 339	138 166	2 432 698	1 233 804	4 870 151	30 652 348	24 548 392	107 512	4 446 393	24 803 840

[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry [2] Total activity includes sales and head offices.
[3] Includes eastern Canada offshore [4] Includes western Canada offshore [5] Includes Arctic Islands and offshore
Note: Totals may not add due to rounding

TABLE 37. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRY BY REGION[1], 1986

	Mineral Manufacturing Activity								Total Activity[2]		
		Production and Related Workers			Costs						
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Shipments	Value Added	Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)	(number)	($000)	($000)
Primary Metals Industry											
Atlantic Provinces	9	x	x	x	x	x	x	x	x	x	x
Quebec	111	18 739	38 420	655 459	383 902	2 490 318	5 110 743	2 210 860	26 585	993 190	2 194 281
Ontario	228	48 263	105 197	1 629 384	521 180	5 147 854	9 732 116	3 978 087	62 429	2 230 182	3 996 084
Prairie Provinces	49	x	x	x	x	x	x	x	x	x	x
British Columbia	46	4 585	8 988	154 410	15 048	351 657	845 845	468 047	6 226	225 783	468 660
Yukon and Northwest Territories	–	–	–	–	–	–	–	–	–	–	–
Canada	443	78 149	166 145	2 633 458	1 050 082	8 722 056	17 108 965	7 179 291	103 511	3 706 507	7 182 025
Nonmetallic Mineral Products Industry											
Atlantic Provinces	117	x	x	x	x	x	x	x	x	x	x
Quebec	396	x	x	x	x	x	x	x	x	x	x
Ontario	590	21 367	45 569	580 102	269 874	1 368 063	3 526 753	1 880 291	27 437	801 450	1 985 605
Prairie Provinces	317	5 532	11 505	147 598	61 954	386 754	919 687	469 536	6 982	196 306	477 540
British Columbia	193	2 828	5 814	91 023	37 625	206 129	488 574	242 987	3 777	126 175	254 695
Yukon and Northwest Territories	–	–	–	–	–	–	–	–	–	–	–
Canada[r]	1 613	42 011	88 155	1 121 460	526 648	2 630 676	6 632 011	3 472 112	53 490	1 527 887	3 614 272
Fabricated Metal Products Industry[3]											
Atlantic Provinces	182	2 433	5 086	54 297	4 454	147 542	265 212	113 405	3 135	72 833	118 237
Quebec	1 215	27 385	55 722	589 847	54 947	1 509 528	3 010 086	1 460 038	33 670	782 218	1 487 715
Ontario	3 011	74 167	158 919	1 736 078	142 728	4 952 230	9 626 750	4 583 491	88 776	2 227 985	4 695 649
Prairie Provinces	692	10 666	22 241	244 187	18 726	606 288	1 242 872	623 046	13 636	332 558	645 275
British Columbia	559	6 869	13 795	185 416	12 939	439 868	879 380	425 363	8 666	249 511	444 576
Yukon and Northwest Territories	–	–	–	–	–	–	–	–	–	–	–
Canada	5 659	121 520	255 762	2 809 825	233 792	7 655 455	15 024 300	7 205 344	147 883	3 665 104[r]	7 391 452
Refined Petroleum and Coal Products Industry											
Atlantic Provinces	7	x	x	x	x	x	x	x	x	x	x
Quebec	26	1 098	2 509	42 680	74 308	2 325 901	2 738 626	99 930	1 498	60 965	100 144
Ontario	46	2 597	5 959	111 759	111 971	4 680 206	5 683 562	671 784	7 512	318 504	657 876
Prairie Provinces	32	x	x	x	x	x	x	x	x	x	x
British Columbia	14	x	x	x	x	x	x	x	x	x	x
Yukon and Northwest Territories	1	x	x	x	x	x	x	x	x	x	x
Canada	126	6 359	14 122	265 156	285 623[r]	12 798 291	15 756 365	1 931 717[r]	15 066	664 420	1 936 938[r]

Total Mineral Manufacturing Industry											
Atlantic Provinces	315	x	x	x	x	x	x	x	x	x	x
Quebec	1 748	x	x	x	x	x	x	x	x	x	x
Ontario	3 875	146 394	315 644	4 057 323	1 045 753	16 148 353	28 569 181	11 113 653	186 154	5 578 121	11 335 214
Prairie Provinces	1 090	x	x	x	x	x	x	x	x	x	x
British Columbia	812	x	x	x	x	x	x	x	x	x	x
Yukon and Northwest Territories	1	x	x	x	x	x	x	x	x	x	x
Canada[1]	7 841	248 039	524 184	6 829 899	2 096 145	31 806 478	54 521 641	19 788 464	319 950	9 563 918	20 124 687

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[1] The Fabricated Metal Products Industry is now included [2] Total activity includes sales and head offices 3 For reasons of confidentiality, SIC 305 (Wire and wire products), normally included in Primary Metals is included in Fabricated Metal Products

x Confidential; - Nil, r Revised

TABLE 38. CANADA, PRINCIPAL STATISTICS OF THE MINERAL INDUSTRY, 1981–87

	Mines, Quarries and Oil Well Activity									Total Activity²		
		Production and Related Workers			Costs							
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added		Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)		(number)	($000)	($000)
1981	1 361	81 136	167 307	2 053 760	888 554	4 266 637	28 204 485	23 049 295		129 251	3 439 945	23 091 447
1982	1 247	74 178	141 070	2 008 439	956 296	3 768 771	29 101 618	24 376 549		123 486	3 648 004	24 427 308
1983	1 407	66 629	131 406	1 963 773	1 022 417	3 756 625	32 771 401	27 992 357		113 831	3 687 911	28 012 167
1984	1 381	69 650	140 567	2 295 256	1 204 008	4 290 972	37 976 019	32 481 039		115 790	4 106 049	32 545 525
1985	1 386	67 308	140 780	2 357 868	1 264 619	4 442 358	38 127 807	34 420 830		117 161	4 413 258	32 495 098
1986	1 508	64 355	135 042	2 367 488	1 240 373	4 649 768	27 778 340	21 888 200		111 461	4 493 254	22 216 741
1987	1 276	64 339	138 166	2 432 698	1 233 804	4 870 151	30 652 348	24 548 392		107 512	4 446 393	24 803 840

[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry [2] Includes sales and head offices

TABLE 39. CANADA, PRINCIPAL STATISTICS OF THE MINERAL MANUFACTURING INDUSTRIES[1], 1980–87

	Mines, Quarries and Oil Well Activity									Total Activity²		
		Production and Related Workers			Costs							
	Establishments	Employees	Person-hours Paid	Wages	Fuel and Electricity	Materials and Supplies	Value of Production	Value Added		Employees	Salaries and Wages	Value Added
	(number)	(number)	(000)	($000)	($000)	($000)	($000)	($000)		(number)	($000)	($000)
1980	7 229	270 529	565 988	4 991 451	1 411 101	28 394 177	43 895 507	14 758 224		366 120	7 262 688	15 160 467
1981	7 196	261 364	546 732	5 393 636	1 720 151	34 570 420	51 870 979	16 791 049		361 883	8 076 300	17 200 686
1982	5 687	229 518	475 378	5 333 201	1 728 740	34 241 605	50 045 037	14 497 245		321 785	8 126 238	14 823 990
1983	7 370	216 944	447 947	5 420 307	1 905 777	34 720 416	52 773 875	15 861 491		301 112	8 143 674	16 196 749
1984	7 511	223 816	470 367	5 948 626	2 125 032	37 738 117	57 207 764	17 980 271		304 309	8 719 151	18 265 131
1985	7 625	238 544	506 377	6 507 081	2 229 270	39 497 925	61 241 939	19 305 730		313 850	9 271 447	19 646 938
1986	7 841	248 039	524 184	6 829 899	2 096 145	31 806 478	54 521 641	19 788 464		319 950	9 563 918	20 124 687
1987	7 598	..	..	..	2 155 505	38 040 328	62 596 533	..		333 015	10 170 080	22 760 933

[1] All years have been revised to include the Fabricated Metal Products industry [2] Total activity includes sales and head offices
.. Not available

TABLE 40. CANADA, CONSUMPTION OF FUEL AND ELECTRICITY IN THE MINERAL INDUSTRY[1], 1987

	Unit	Metals	Industrials[2]	Fuels	Total
Coal	000 t	284	–	–	284
	$000	19 782	–	–	19 782
Gasoline	000 litres	19 692	17 279	9 786	46 757
	$000	7 950	7 091	3 203	18 244
Fuel oil, kerosene, diesel oil	000 litres	742 294	265 111	219 219	1 226 624
	$000	167 441	73 692	53 258	294 391
Liquefied petroleum gas	000 litres	92 071	10 918	16 541	119 530
	$000	15 993	2 243	2 327	20 563
Natural gas	000 m^3	225 789	537 854	73	763 716
	$000	28 000	54 847	8 315	91 162
Other fuels[3]	$000	10 766	–	–	10 766
Total value of fuels	$000	249 932	137 873	67 103	454 908
Electricity purchased	million kWh	12 128	2 237	7 822	22 187
	$000	345 068	96 876	336 952	778 896
Total value of fuels and electricity purchased, all reporting companies	$000	595 000	234 749	404 055	1 233 804

[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials. [3] Includes wood, manufactured gas, steam purchased and other miscellaneous fuels.
– Nil
Note: Totals may not add due to rounding.

TABLE 41. CANADA, COST OF FUEL AND ELECTRICITY USED IN THE MINING INDUSTRY[1], 1981–87

	Unit	1981	1982	1983	1984	1985	1986	1987
Metals								
Fuel	$000	293 979	275 205	270 098	331 231	337 445	276 894	249 932
Electricity purchased	million kWh	10 494	9 891	9 659	11 672	11 504	12 066	12 128
	$000	209 316	232 137	238 458	272 932	281 373	320 828	345 068
Total cost of fuel and electricity	$000	503 295	507 342	508 556	604 163	618 818	597 722	595 000
Industrials[2]								
Fuel	$000	142 169	143 393	157 872	169 486	165 665	153 442	137 873
Electricity purchased	million kWh	2 100	1 782	1 928	2 120	2 122	2 107	2 237
	$000	56 297	57 567	64 052	76 884	82 114	86 571	96 876
Total cost of fuel and electricity	$000	198 466	200 960	221 924	246 370	247 779	240 013	234 749
Fuels								
Fuel	$000	46 991	70 484	68 800	89 237	101 049	73 426	67 103
Electricity purchased	million kWh	3 740	5 780	4 958	5 840	6 569	7 183	7 822
	$000	139 802	176 911	223 136	264 233	296 973	329 208	336 952
Total cost of fuel and electricity	$000	186 793	247 395	291 936	353 470	398 022	402 634	404 055
Total mining industry								
Fuel	$000	483 139	489 082	496 770	589 954	604 159	503 762	454 908
Electricity purchased	million kWh	16 334	17 453	16 545	19 632	20 195	21 356	22 187
	$000	405 415	466 615	525 646	614 049	660 460	736 607	778 896
Total cost of fuel and electricity	$000	888 554	955 697	1 022 416	1 204 003	1 264 619	1 240 369	1 233 804

[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry. [2] Includes structural materials.

TABLE 42. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINING INDUSTRY[1],1981-87

	Unit	1981	1982	1983	1984	1985	1986	1987
Metals								
Production and related workers	Number	49 586	44 261	37 270	39 181	36 618	34 941	34 329
Salaries and wages	$000	1 265 547	1 180 485	1 110 308	1 296 157	1 288 990	1 308 956	1 327 119
Annual average salary and wage	$	25 522	26 671	29 791	33 081	35 201	37 462	38 659
Administrative and office workers	Number	19 126	17 242	14 924	13 502	12 054	11 546	11 167
Salaries and wages	$000	585 120	585 249	533 517	518 644	487 398	489 402	489 609
Annual average salary and wage	$	30 593	33 943	35 749	38 412	40 435	42 387	43 844
Total metals								
Employees	Number	68 712	61 503	52 194	52 683	48 672	46 487	45 496
Salaries and wages	$000	1 850 667	1 765 734	1 643 825	1 814 801	1 776 388	1 798 358	1 816 728
Annual average salary and wage	$	26 934	28 710	31 495	34 448	36 497	38 685	39 932
Industrials								
Production and related workers	Number	15 666	12 848	12 768	13 008	12 535	12 376	12 989
Salaries and wages	$000	352 302	309 736	329 201	356 828	354 460	361 039	401 626
Annual average salary and wage	$	22 488	24 108	25 783	27 431	28 278	29 173	30 920
Administrative and office workers	Number	4 908	4 323	3 805	4 250	4 380	4 887	4 930
Salaries and wages	$000	128 852	129 116	115 378	138 012	148 090	169 237	183 979
Annual average salary and wage	$	26 253	29 867	30 323	32 473	33 811	34 630	37 318
Total industrials								
Employees	Number	20 574	17 171	16 573	17 258	16 915	17 263	17 919
Salaries and wages	$000	481 154	438 852	444 579	494 840	502 550	530 276	585 605
Annual average salary and wage	$	23 387	25 558	26 825	28 673	29 710	30 717	32 681
Fuels								
Production and related workers	Number	15 884	17 069	16 591	17 461	18 155	17 038	17 021
Salaries and wages	$000	435 911	518 217	524 264	642 271	714 418	697 494	703 953
Annual average salary and wage	$	27 443	30 360	31 599	36 783	39 351	40 938	41 358
Administrative and office workers	Number	24 081	27 743	28 473	28 388	33 419	30 673	27 076
Salaries and wages	$000	672 213	925 201	1 075 245	1 154 137	1 419 903	1 467 126	1 340 107
Annual average salary and wage	$	27 915	33 349	37 764	40 656	42 488	47 831	49 494
Total fuels								
Employees	Number	39 965	44 812	45 064	45 849	51 574	47 711	44 097
Salaries and wages	$000	1 108 124	1 443 418	1 599 509	1 796 408	2 134 321	2 164 620	2 044 060
Annual average salary and wage	$	27 727	32 211	35 494	39 181	41 384	45 369	46 354
Total mining								
Production and related workers	Number	81 136	74 178	66 629	69 650	67 308	64 355	64 339
Salaries and wages	$000	2 053 760	2 008 438	1 963 773	2 295 256	2 357 868	2 367 489	2 432 698
Annual average salary and wage	$	25 313	27 076	29 473	32 954	35 031	36 788	37 811
Administrative and office workers	Number	48 115	49 308	47 202	46 140	49 853	47 106	43 173
Salaries and wages	$000	1 386 185	1 639 566	1 724 140	1 810 793	2 055 391	2 125 765	2 013 695
Annual average salary and wage	$	28 810	33 252	36 527	39 246	41 229	45 127	46 642
Total mining								
Employees	Number	129 251	123 486	113 831	115 790	117 161	111 461	107 512
Salaries and wages	$000	3 439 945	3 648 004	3 687 913	4 106 049	4 413 259	4 493 254	4 446 393
Annual average salary and wage	$	26 614	29 542	32 398	35 461	37 668	40 312	41 357

[1] Cement manufacturing, lime manufacturing, clay and clay products (domestic clays) are included in the mineral manufacturing industry

Note Totals may not add due to rounding

TABLE 43. CANADA, EMPLOYMENT, SALARIES AND WAGES IN THE MINERAL MANUFACTURING INDUSTRIES[1], 1981–87

	Unit	1981	1982	1983	1984	1985	1986	1987
Primary Metal Industries[2]								
Production and related workers	Number	105 518	92 621	87 769	92 336	92 695	90 035	..
Salaries and wages	$000	2 355 537	2 368 939	2 445 267	2 818 413	2 940 777	2 924 986	..
Annual average salary and wage	$	22 324	25 577	27 860	30 523	31 725	32 487	..
Administrative and office workers	Number	36 959	34 563	31 076	30 826	29 467	28 738	..
Salaries and wages	$000	1 039 467	1 104 327	1 055 120	1 131 842	1 159 060	1 182 287	..
Annual average salary and wage	$	28 125	31 951	33 953	36 717	39 334	41 140	..
Total primary metal industries[2]								
Employees	Number	142 477	127 184	118 845	123 162	122 162	118 773	119 386
Salaries and wages	$000	3 395 004	3 473 266	3 500 387	3 950 255	4 099 837	4 107 273	4 244 950
Annual average salary and wage	$	23 828	27 309	29 453	32 074	33 561	34 581	35 557
Nonmetallic Mineral Products Industries								
Production and related workers	Number	40 145	33 997	34 097	36 155	38 763	42 011	45 158
Salaries and wages	$000	818 566	751 915	800 755	883 604	1 001 780	1 121 460	1 234 942
Annual average salary and wage	$	20 390	22 117	23 485	24 439	25 844	26 694	27 347
Administrative and office workers	Number	15 124	13 952	13 353	12 738	11 842	11 479	11 664
Salaries and wages	$000	369 899	383 405	391 901	394 619	397 129	406 427	433 926
Annual average salary and wage	$	24 458	27 480	29 349	30 980	33 536	35 406	37 202
Total nonmetallic mineral products								
Employees	Number	55 269	47 949	47 450	48 893	50 605	53 490	56 822
Salaries and wages	$000	1 188 455	1 135 320	1 192 656	1 278 223	1 398 911	1 527 887	1 668 868
Annual average salary and wage	$	21 503	23 678	25 135	26 143	27 644	28 564	29 370
Fabricated Metal Products Industries								
Production and related workers	Number	107 269	94 779	87 661	88 787	100 650	109 634	..
Salaries and wages	$000	1 970 334	1 946 325	1 910 181	1 983 782	2 298 665	2 518 297	..
Annual average salary and wage	$	18 368	20 535	21 791	22 343	22 838	22 970	..
Administrative and office workers	Number	34 254	30 372	28 239	26 203	23 694	22 987	..
Salaries and wages	$000	836 878	803 920	785 881	778 057	751 973	746 041	..
Annual average salary and wage	$	24 432	26 469	27 830	29 693	31 737	32 455	..
Total fabricated metal products industries								
Employees	Number	141 523	125 151	115 900	114 990	124 344	132 621	141 659
Salaries and wages	$000	2 807 212	2 750 245	2 696 062	2 761 839	3 050 638	3 264 338	3 547 954
Annual average salary and wage	$	19 836	21 975	23 262	24 018	24 534	24 614	25 046
Petroleum and Coal Products Industries								
Production and related workers	Number	8 432	8 121	7 417	6 538	6 436	6 359	..
Salaries and wages	$000	249 199	266 022	264 104	262 827	265 859	265 156	..
Annual average salary and wage	$	29 554	32 757	35 608	40 200	41 308	41 698	..
Administrative and office workers	Number	14 182	13 380	11 500	10 726	10 303	8 707	..
Salaries and wages	$000	436 430	501 385	490 465	466 006	456 202	399 264	..
Annual average salary and wage	$	30 773	37 473	42 649	43 446	44 279	45 856	..
Total petroleum and coal products industries								
Employees	Number	22 614	21 501	18 917	17 264	16 739	15 066	15 148
Salaries and wages	$000	685 629	767 407	754 569	728 833	722 061	664 420	708 308
Annual average salary and wage	$	30 319	35 692	39 888	42 217	43 136	44 101	46 759
Total Mineral Manufacturing Industries								
Production and related workers	Number	261 364	229 518	216 944	223 816	238 544	248 039	..
Salaries and wages	$000	5 393 636	5 333 201	5 420 307	5 948 626	6 507 081	6 829 899	..
Annual average salary and wage	$	20 636	23 237	24 985	26 578	27 278	27 536	..
Administrative and office workers	Number	100 519	92 267	84 168	80 493	75 306	71 911	..
Salaries and wages	$000	2 682 664	2 793 037	2 723 367	2 770 525	2 764 366	2 734 019	..
Annual average salary and wage	$	26 688	30 271	32 356	34 419	36 708	38 019	..
Total mineral manufacturing industries								
Employees	Number	361 883	321 785	301 112	304 309	313 850	319 950	333 015
Salaries and wages	$000	8 076 300	8 126 238	8 143 674	8 719 151	9 271 447	9 563 918	10 170 080
Annual average salary and wage	$	22 317	25 254	27 045	28 652	29 541	29 892	30 539

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[1] All years have been revised to include the Fabricated Metal Products industry. [2] Wire and Wire Products have been included in Stage III.
.. Not available.

TABLE 44. CANADA, NUMBER OF WAGE EARNERS EMPLOYED IN THE MINING INDUSTRY (SURFACE, UNDERGROUND AND MILL), 1981–87

	1981	1982	1983	1984	1985	1986	1987
Metals							
Surface	14 043	12 133	9 970	9 724	10 093	9 674	9 557
Underground	19 784	18 673	15 861	16 668	14 798	13 982	13 747
Mill	15 759	13 455	11 439	12 789	11 727	11 285	11 025
Total	49 586	44 261	37 270	39 181	36 618	34 941	34 329
Industrials							
Surface	6 015	4 833	4 951	4 948	4 921	5 396	5 771
Underground	2 606	2 055	2 192	2 487	2 337	2 112	2 234
Mill	7 045	5 960	5 625	5 573	5 277	4 868	4 984
Total	15 666	12 848	12 768	13 008	12 535	12 376	12 989
Fuels							
Surface	11 429	13 283	12 190	14 392	15 101	14 165[e]	14 063[e]
Underground	2 926	3 226	2 896	1 818	1 626	1 602[e]	1 655[e]
Mill	1 529	560	1 505	1 251	1 428	1 271	1 304[e]
Total	15 884	17 069	16 591	17 461	18 155	17 038	17 022
Total Mining Industry							
Surface	31 487	30 249	27 111	29 064	30 115	29 235	29 391
Underground	25 316	23 954	20 949	20 973	18 761	17 696	17 636
Mill	24 333	19 975	18 569	19 613	18 432	17 424	17 313
Total	81 136	74 178	66 629	69 650	67 308	64 355	64 340

[e] Estimated.
Note: Totals may not add due to rounding.

TABLE 45. CANADA, MINE AND MILL WORKERS BY SEX, 1987

	Mine Workers				Mill Workers		Total	
	Underground		Surface					
	Male	Female	Male	Female	Male	Female	Male	Female
Metallic minerals								
Nickel–copper–zinc[1]	6 301	18	4 284	100	3 620	117	13 845	235
Gold	4 064	10	1 228	79	2 143	74	7 435	163
Iron ore	96	1	1 083	8	3 050	81	4 229	90
Uranium	1 886	15	1 658	32	728	74	4 272	121
Silver–lead–zinc	1 234	4	648	48	1 206	29	3 088	81
Miscellaneous metal mines[2]	118	–	387	2	252	11	757	13
Total	13 699	48	9 288	269	10 639	386	33 626	703
Industrial minerals								
Asbestos	136	–	769	9	1 236	35	2 141	44
Potash	1 442	14	87	2	1 470	35	2 999	51
Miscellaneous nonmetals[3]	479	–	383	1	1 108	30	1 970	31
Stone	5	–	2 014	13	210	2	2 229	15
Peat	–	–	591	23	619	22	1 210	45
Sand and gravel	–	–	1 436	27	134	–	1 570	27
Gypsum	158	–	416	–	83	–	657	0
Total	2 220	14	5 696	75	4 860	124	12 776	213
Fuels								
Coal	1 655e	–	5 434e	66e	1 284e	20e	8 373	86
Mining total	17 574	62	20 418	410	16 783	530	54 775	1 002

[1] Includes copper–zinc and nickel–copper mines. [2] Includes molybdenum mines. [3] Includes quartz mines and salt mines.
– Nil; e Estimated.

TABLE 46. CANADA, LABOUR COSTS FOR METAL MINES IN RELATION TO TONNES MINED, 1985–87

Type of Metal Mine	Number of Wage Earners	Total Wages	Average Annual Wage	Tonnage of Ore Mined	Average Annual Tonnes Mined per Wage Earner	Wage Cost per Tonne Mined
		($000)	($)	(kilotonnes)		($)
1985						
Uranium	4 024	158 110	39 292	7 183	1 785	22.01
Gold	4 507	162 094	35 965	11 997	2 662	13.51
Silver–lead–zinc	1 982	73 202	36 933	9 970	5 030	7.34
Miscellaneous metals[1]	532	18 412	34 609	4 068	7 647	4.53
Nickel–copper–zinc[2]	12 335	415 630	33 695	117 169	9 499	3.55
Iron ore	1 511	58 147	38 482	94 588	62 600	0.61
Total	24 891	885 595	35 579	244 975	9 842	3.62
1986						
Uranium	3 796	161 248	42 478	6 933	1 826	23.26
Gold	4 620	181 873	39 366	14 072	3 046	12.92
Silver–lead–zinc	1 801	68 971	38 296	12 084	6 710	5.71
Miscellaneous metals[1]	546	19 674	36 033	8 360	15 311	2.35
Nickel–copper–zinc[2]	11 585	416 818	35 979	126 658	10 933	3.29
Iron ore	1 308	51 760	39 572	88 231	67 455	0.59
Total	23 656	900 344	38 060	256 338	10 836	3.51
1987						
Uranium	3 591	152 184	42 379	6 383	1 778	23.84
Gold	5 381	218 960	40 691	15 326	2 848	14.29
Silver–lead–zinc	1 934	76 664	39 640	15 147	7 832	5.06
Miscellaneous metals[1]	507	15 970	31 499	11 787	23 248	1.35
Nickel–copper–zinc[2]	10 703	397 886	37 175	130 452	12 188	3.05
Iron ore	1 188	48 729	41 018	87 077	73 297	0.56
Total	23 304	910 393	39 066	266 172	11 422	3.42

[1] Includes molybdenum mines [2] Includes copper–zinc and nickel–copper mines.

TABLE 47. CANADA, PERSON–HOURS PAID FOR PRODUCTION AND RELATED WORKERS, AND TONNES OF ORE MINED AND ROCK QUARRIED IN METAL MINES AND OTHER MINERAL OPERATIONS,1981–87

	Unit	1981	1982	1983	1984	1985	1986	1987
Metal mines[1]								
Ore mined	million t	301.5	238.4	219.0	246.4	245.0	256.3	266.2
Person–hours paid[2]	million	100.6	80.4	71.8	78.2	77.1	73.6	74.9
Person–hours paid per tonne mined	number	0.33	0.34	0.33	0.32	0.31	0.29	0.28
Tonnes mined per person–hour paid	t	3.00	2.97	3.05	3.15	3.18	3.48	3.55
Other mineral operations[3]								
Ore mined and rock quarried	million t	110.5	93.2	101.6	132.3	138.2	127.4	135.3
Person–hours paid[2]	million	38.6	34.8	32.2	34.0	31.3	28.9	29.9
Person–hours paid per tonne mined	number	0.35	0.37	0.32	0.26	0.23	0.23	0.22
Tonnes mined per person–hour paid	t	2.86	2.68	3.16	3.89	4.42	4.41	4.53

[1] Excludes placer mining. [2] Person–hours paid for production and related workers only. [3] Includes asbestos, potash, gypsum and coal.

TABLE 48. CANADA, AVERAGE WEEKLY WAGES AND HOURS WORKED (INCLUDING OVERTIME) FOR HOURLY-RATED EMPLOYEES IN MINING, MANUFACTURING AND CONSTRUCTION INDUSTRIES, 1982–88

	1982	1983[1]	1984	1985	1986	1987	1988
Mining							
Average hours per week	39.6	38.8	39.3	39.6	39.7	40.0	40.7
Average weekly wage ($)	551.68	552.79	664.56	697.90	711.05	726.40	771.17
Metals							
Average hours per week	39.0	38.3	38.8	39.1	39.6	39.6	39.9
Average weekly wage ($)	535.92	565.64	610.77	639.89	657.62	678.84	775.78
Mineral fuels							
Average hours per week	42.1	39.7	40.6	40.8	40.9	41.6	42.1
Average weekly wage ($)	631.91	627.26	672.95	716.79	711.40	729.26	895.20
Nonmetals							
Average hours per week	37.2	37.7	38.7	39.2	39.6	39.7	39.7
Average weekly wage ($)	479.44	503.58	536.20	554.88	581.84	595.98	655.89
Manufacturing							
Average hours per week	37.7	38.4	38.5	38.8	38.8	38.8	38.8
Average weekly wage ($)	384.79	504.76	465.66	488.17	504.04	519.54	544.76
Construction							
Average hours per week	38.1	36.9	37.4	37.8	37.9	38.4	38.5
Average weekly wage ($)	564.33	512.26	491.24	505.07	510.40	539.37	562.69

[1] Ten-month average: new time series.

TABLE 49. CANADA, AVERAGE WEEKLY WAGES (INCLUDING OVERTIME) OF HOURLY-RATED EMPLOYEES IN THE MINING INDUSTRY, IN CURRENT AND 1981 DOLLARS, 1982–88

	1982	1983	1984[1]	1985	1986	1987	1988
Current dollars							
All mining	551.68	552.79	664.56	697.90	711.05	726.40	771.17
Metals	535.92	565.64	610.77	639.89	657.62	678.84	775.78
Mineral fuels	631.91	627.26	672.95	716.79	711.40	729.26	895.20
Coal	567.44	564.18	653.42	697.30	718.82	729.54	791.90
Industrial minerals	479.44	503.58	536.20	554.88	581.84	595.98	655.89
1981 dollars (CPI)							
All mining	497.90	471.66	543.39	548.66	537.05	525.62	536.28
Metals	483.68	482.59	499.40	503.06	496.69	491.20	539.49
Mineral fuels	570.32	534.23	550.25	563.51	537.31	527.68	622.53
Coal	507.33	481.38	534.28	548.19	542.92	527.89	550.70
Industrial minerals	432.71	430.68	438.43	436.23	439.46	431.24	456.11

[1] Ten-month average: new time series.
CPI Consumer Price Index – all items.

TABLE 50. CANADA, INDUSTRIAL FATALITIES PER THOUSAND WORKERS[1] BY INDUSTRY GROUPS, 1986-88

	Fatalities			Number of Workers			Rate per 1000 Workers		
	1986	1987	1988p	1986	1987	1988p	1986	1987	1988p
		(number)			(000)				
Agriculture	9	12	9	172	179	164	0.05	0.07	0.05
Forestry	55	61	60	61	62	65	0.90	0.98	0.92
Fishing[2]	14	24	13	14	15	18	1.00	1.60	0.72
Mining[3]	108	114	82	183	181	185	0.59	0.63	0.44
Manufacturing[4]	111	112	125	1 985	2 017	2 097	0.06	0.06	0.06
Construction	141	121	119	522	565	613	0.27	0.21	0.19
Transportation[5]	122	113	101	842	848	860	0.14	0.13	0.12
Trade	59	40	42	1 881	1 928	1 997	0.03	0.02	0.02
Finance[6]	6	5	8	628	661	691	0.01	0.01	0.01
Service[7]	39	40	46	3 383	3 501	3 631	0.01	0.01	0.01
Public Administration[8]	55	38	35	800	814	820	0.07	0.05	0.04
Unknown	3	10	7	..	..	..	..	..	..
Total	722	690	647	10 471	10 771	11 141	0.07	0.06	0.06

[1] Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. Excludes the province of Quebec for which data are unavailable. [2] Includes trapping and hunting. [3] Includes quarrying and oil wells. [4] Includes deaths of workers who were on pension for an earlier disabling injury. [5] Includes storage, communication, electric power and water utilities and highway maintenance. [6] Includes insurance and real estate. [7] Includes community, business and personal services. [8] Includes defence.

.. Not available; p Preliminary.

TABLE 51. CANADA, RATE OF INDUSTRIAL FATALITIES PER THOUSAND WORKERS BY INDUSTRY GROUPS,[1] 1982-88

	1982	1983	1984	1985	1986	1987	1988p[2]
Agriculture	0.13	0.13	0.13	0.12	0.05	0.07	0.05
Forestry	1.22	0.97	0.88	1.08	0.90	0.98	0.92
Fishing[3]	1.58	1.07	1.93	2.17	1.00	1.60	0.72
Mining[4]	0.96	0.63	0.57	0.69	0.59	0.63	0.44
Manufacturing[5]	0.11	0.08	0.07	0.07	0.06	0.06	0.06
Construction	0.35	0.25	0.31	0.28	0.27	0.21	0.19
Transportation[6]	0.22	0.17	0.15	0.16	0.14	0.13	0.12
Trade	0.04	0.03	0.03	0.04	0.03	0.02	0.02
Finance[7]	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Service[8]	0.03	0.03	0.02	0.02	0.01	0.01	0.01
Public Administration[9]	0.08	0.07	0.08	0.07	0.07	0.05	0.04
Total	0.11	0.08	0.08	0.09	0.07	0.06	0.06

[1] Includes fatalities resulting from occupational chest illnesses such as silicosis, lung cancer, etc. Excludes the province of Quebec for which data are unavailable. [2] Prior to 1983, the rates may be understated because only 80 percent of workers in the Statistics Canada employment estimates are covered by workers' compensation; beginning 1983, the rates include 100 percent of workers. [3] Includes trapping and hunting. [4] Includes quarrying and oil wells. [5] Includes deaths of workers who were on pension for an earlier disabling injury. [6] Includes storage, communication, electric power and water utilities and highway maintenance. [7] Includes insurance and real estate. [8] Includes community, business and personal services. [9] Includes defence.
p Preliminary

TABLE 52. CANADA, INDUSTRIAL FATALITIES BY OCCUPATIONAL INJURIES AND ILLNESSES,[1] 1986-88

	Occupational Injuries			Occupational Illnesses			Total		
	1986	1987	1988p	1986	1987	1988p	1986	1987	1988p
Agriculture	9	12	9	0	0	0	9	12	9
Forestry	55	61	60	0	0	0	55	61	60
Fishing[2]	14	24	13	0	0	0	14	24	13
Mining[3]	57	63	50	51	51	32	108	114	82
Manufacturing[4]	87	72	92	24	40	33	111	112	125
Construction	113	102	90	28	19	29	141	121	119
Transportation[5]	118	111	98	4	2	3	122	113	101
Trade	56	37	37	3	3	5	59	40	42
Finance[6]	6	5	7	0	0	1	6	5	8
Service[7]	37	40	45	2	0	1	39	40	46
Public Administration[8]	50	31	32	5	7	3	55	38	35
Unknown	0	8	5	0	2	2	0	10	7
Total	602	566	538	117	124	109	719	690	647

[1] Includes fatalities resulting from occupational chest illness such as silicosis, lung cancer, etc. Excludes the province of Quebec for which data are unavailable. [2] Includes trapping and hunting. [3] Includes quarrying and oil wells. [4] Includes deaths of workers who were on pension for an earlier disabling injury. [5] Includes storage, communication, electric power and water utilities and highway maintenance. [6] Includes insurance and real estate. [7] Includes community, business and personal services. [8] Includes defence.

p Preliminary.

TABLE 53. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY INDUSTRIES, 1986-88

	1986			1987			1988^{p}		
	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days
Agriculture	0	0	0	1	18	3 800	1	18	4 610
Forestry	9	27 813	2 024 930	5	882	2 510	4	963	19 520
Fishing and trapping	0	0	0	0	0	0	0	0	0
Mines	14	8 796	351 870	14	8 902	228 440	13	4 481	160 014
Manufacturing	317	54 977	1 386 070	302	82 463	1 756 362	260	49 621	1 393 266
Construction	48	151 941	1 963 500	21	8 363	53 620	21	34 156	632 030
Transportation and utilities	59	23 859	314 160	64	125 408	689 640	48	38 602	2 011 890
Trade	109	8 443	234 940	94	8 420	326 820	85	7 351	189 615
Finance, insurance and real estate	13	885	32 570	13	622	29 930	9	489	29 990
Service	125	133 695	302 705	113	58 750	549 995	85	36 183	427 208
Public administration	41	73 206	506 860	28	288 707	326 920	24	35 935	168 890
Various industries	0	0	0	0	0	0	0	0	0
All industries	735	483 615	7 117 605^{r}	655^{r}	582 535^{r}	3 968 037^{r}	550	207 799	5 037 033

^{p} Preliminary; ^{r} Revised

TABLE 54. CANADA, NUMBER OF STRIKES AND LOCKOUTS BY MINING AND MINERAL MANUFACTURING INDUSTRIES, 1986-88

	1986			1987			1988^p		
	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days	Strikes and Lockouts	Workers Involved	Duration in Person-days
Mines	14	8 796	351 870	14	8 902	228 440	13^r	4 481^r	160 014^r
Metals	7	4 700	52 920	10	7 551	221 170	9^r	3 833^r	122 704^r
Mineral fuels	4	2 977	231 870	2	1 060	1 000	0^r	0^r	0^r
Nonmetals	3	1 119	67 080	1	272	6 210	3^r	626^r	36 850^r
Quarries	0	0	0	1	19	60	1	22	460
Mineral Manufacturing	41	7 136	228 070	41	12 203	451 590	31	8 620	223 515
Primary metals	14	4 422	138 750	21	9 107	369 800	16	6 329	168 095
Nonmetallic mineral products	26	2 598	89 070	20	3 096	81 790	15	2 291	55 420
Petroleum and coal products	1	116	250	0	0	0	0	0	0

^{p} Preliminary; ^{r} Revised

TABLE 55. CANADA, MINING WAGES AND SALARIES, 1986 AND 1987

	1986					1987				
	Metals	Nonmetals	Mineral Fuels	Quarries and Pits	Total	Metals	Nonmetals	Mineral Fuels	Quarries and Pits	Total
			($000)					($000)		
Newfoundland	87 453	10 540	–	703	98 696	87 291	14 227	–	1 007	102 525
Prince Edward Island	–	–	–	–	–	–	–	–	–	–
Nova Scotia	x	x	76 887	5 564	110 730	x	x	76 944	6 222	112 057
New Brunswick	x	x	6 873	3 491	103 194	x	x	6 415	3 621	107 175
Quebec	366 175	93 011	–	41 550	500 736	372 606	99 953	–	49 922	522 481
Ontario	766 059	64 432	17 318	68 509	916 318	750 059	67 317	16 785	94 175	928 336
Manitoba	116 965	4 581	2 469	4 547	128 562	118 925	4 998	3 742	5 553	133 218
Saskatchewan	x	134 951	49 180	x	238 120	x	131 784	37 281	x	225 564
Alberta	x	7 946	1 616 046	x	1 628 844	x	x	1 596 012	x	1 611 869
British Columbia	220 797	16 222	270 441	13 872	521 332	242 686	16 820	269 666	16 018	545 190
Yukon and Northwest Territories	121 316	–	36 008	–	157 324	120 763	–	23 082	–	143 845
Offshore	–	–	14 262	–	14 262	–	–	14 133	–	14 133
CANADA	1 798 360	387 491	2 089 484	142 783	4 418 118	1 816 727	401 732	2 044 060	183 874	4 446 393
T4 Services-Incidental					1 055 005					1 158 621
Canada + T4 Services-Incidental					5 473 123					5 605 014

x Confidential; – Nil.

TABLE 56. EMPLOYMENT FOR SERVICES INCIDENTAL TO MINES, QUARRIES AND OIL WELLS, 1961–89

	Petroleum and Natural Gas Contract Drilling[1]	Mining Diamond Drilling[2]	Other Services Incidental to Mines, Quarries and Oil Wells[3]	Total[4]
		(number)		
1961	4 144	2 025	1 409	7 578
1962	3 800	1 926	1 720	7 446
1963	4 179	2 201	1 491	7 871
1964	4 158	2 401	2 077	8 636
1965	4 648	2 776	3 137	10 561
1966	4 428	2 887	4 317	11 632
1967	4 249	2 669	5 425	12 343
1968	4 434	2 985	6 350	13 769
1969	4 821	3 109	6 967	14 897
1970	4 267	3 207	7 894	15 368
1971	4 093	2 514	7 710	14 317
1972	4 817	2 083	6 139	13 039
1973	5 680	2 123	5 193	12 996
1974	5 054	2 317	5 017	12 388
1975	5 096	1 899	4 139	11 134
1976	5 486	1 548	5 043	12 077
1977	6 054	1 682	5 723	13 459
1978	7 419	1 681	7 492	16 592
1979	9 076	2 420	8 436	19 932
1980	11 097	2 959	9 327	23 383
1981	8 448	2 721	9 856	21 025
1982	6 882	1 880	7 752	16 514
1983	12 032	1 575	12 254	25 861
1984	13 803	1 684	12 698	28 185
1985	18 178	1 625[r]	15 781	35 584[r]
1986	17 703[r]	2 198	16 623[r]	36 524[r]
1987	16 561[e]	3 353	15 124[e]	35 038[e]
1988[p]	15 699	3 057	19 011	37 767
1989[f]	13 207	2 850	18 169	34 226

[1] Statistics Canada Annual Census to 1976, Labour Force Survey or estimate thereafter. [2] Energy, Mines and Resources' Annual Census. [3] Statistics Canada's Labour Force Survey, predominantly servicing the Energy Sector, estimates by EMR/MPS from 1983 onwards. [4] Statistics Canada's Labour Force Survey, estimated by EMR/MPS from 1983 onwards.
[p] Preliminary; [f] Forecast; [r] Revised; [e] Estimated.

TABLE 57. CANADA, SOURCE OF ORES HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1985–87

Mines	1985			1986			1987		
	Underground	Open-pit	Total	Underground	Open-pit	Total	Underground	Open-pit	Total
					(kilotonnes)				
Nickel–copper–zinc	30 184	86 985	117 169	27 486ʳ	98 812ʳ	126 298ʳ	28 040	102 412	130 452
Iron ore	1 953	92 634	94 587	1 660	86 571	88 231	1 434	85 644	87 077
Coal	3 823	72 844	76 667	3 562	69 174	72 736	4 206	73 245	77 452
Potash	34 843	–	34 843	33 563	–	33 563	34 875	–	34 875
Gold	8 424	3 573	11 997	10 208	3 864	14 072	11 593	3 733	15 326
Silver-lead-zinc	7 183	2 787	9 970	7 118	4 965	12 083	7 321	7 826	15 147
Asbestos	1 488	15 630	17 118	1 212	10 596	11 808	1 089	12 437	13 526
Gypsum	1 100	8 508	9 608	1 324	7 851	9 175	1 435	8 004	9 439
Rock salt	7 101	–	7 101	8 460	–	8 460	7 091	–	7 091
Miscellaneous metals	1 288	2 779	4 067	1 127	7 234	8 361	909	10 878	11 787
Uranium	6 627	555	7 182	6 313	620	6 933	5 716	667	6 383
Miscellaneous nonmetals	130	2 906	3 036	409	2 988	3 397	192	3 372	3 564
Total	104 144	289 201	393 345	102 442ʳ	292 675ʳ	395 117ʳ	103 902	308 217	412 119
Percentage	26.5	73.5	100.0	27.9ʳ	74.1ʳ	100.0	25.2	74.8	100.0

ʳ Revised; – Nil.
Note: Totals may not add due to rounding.

TABLE 58. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1986

	Underground		Open-pit			
	Ore	Waste	Ore	Waste	Overburden	Tailings
			(kilotonnes)			
Nickel-copper-zinc	27 486^{r}	3 964^{r}	98 812^{r}	101 267^{r}	25 036	119 197
Iron ore	1 660	17	86 571	23 705	6 476	53 107
Coal	3 562	. .	69 174	. .	. .	. .
Potash	33 563	22	–	–	–	23 376
Gold	10 208	2 068	3 864	7 061	1 897	12 917
Silver-lead-zinc	7 118	643	4 965	11 852	2 439	10 504
Asbestos	1 212	–	10 596	23 774	468	7 935
Gypsum	1 324	59	7 851	2 431	6 013	73
Rock salt	8 460	605	–	–	–	855
Miscellaneous metals	1 127	63	7 234	3 368	–	5 267
Uranium	6 313	348	620	5 845	1 121	7 058
Miscellaneous nonmetals	409	2	2 988	700	116	427
Total	102 442^{r}	7 791^{r}	292 675^{r}	180 003^{r}	43 566	240 716

– Nil; . . Not available; ^{r} Revised.

Note: Totals may not add due to rounding.

TABLE 58a. CANADA, SOURCE OF MATERIAL HOISTED OR REMOVED FROM SELECTED TYPES OF MINES, 1987

	Underground		Open-pit			
	Ore	Waste	Ore	Waste	Overburden	Tailings
			(kilotonnes)			
Nickel-copper-zinc	28 040	3 974	102 412	104 688	2 943	121 501
Iron ore	1 434	3	85 644	12 831	5 373	51 469
Coal	4 206	. .	73 245	. .	. .	. .
Potash	34 875	16	–	–	–	22 798
Gold	11 593	3 565	3 733	11 330	30	14 869
Silver-lead-zinc	7 321	317	7 826	5 255	–	124 845
Asbestos	1 089	–	12 437	28 533	2 858	7 071
Gypsum	1 435	56	8 004	1 743	5 232	576
Rock salt	7 091	595	–	–	–	886
Miscellaneous metals	909	26	10 878	6 352	–	8 710
Uranium	5 716	259	667	5 630	3 310	6 399
Miscellaneous nonmetals	192	39	3 372	730	185	584
Total	103 902	8 812	308 217	177 092	19 930	359 709

– Nil; . . Not available.

Note: Totals may not add due to rounding.

TABLE 59. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1981–87

	1981	1982	1983	1984	1985	1986	1987
				(kilotonnes)			
Metals							
Nickel–copper–zinc	137 709	117 833	116 532	124 682	117 169	126 298^{r}	130 452
Iron	118 579	81 963	74 597	89 210	94 587	88 231	87 077
Gold	6 810	8 368	9 553	11 225	11 997	14 072	15 326
Silver–lead–zinc	15 964	14 113	9 157	10 084	9 970	12 083	15 147
Miscellaneous metals	15 014	8 477	2 133	3 627	4 067	8 361	11 787
Uranium	7 454	7 608	7 073	7 608	7 182	6 933	6 383
Total	301 530	238 362	219 045	246 436	244 972	255 978^{r}	266 172
Nonmetals							
Potash	30 344	16 946	24 222	36 542	34 843	33 563	34 875
Asbestos	25 664	17 493	15 035	15 726	17 118	11 808	13 526
Gypsum	6 220	5 830	7 540	8 869	9 608	9 175	9 439
Rock salt	4 927	5 723	5 996	6 706	7 101	8 460	7 091
Miscellaneous nonmetals	2 788	1 995	2 922^{r}	3 825	3 036	3 397	3 564
Total	69 943	47 987	55 715^{r}	71 668	71 706	66 403	68 496
Structural materials							
Stone, all kinds quarried[1]	86 860	59 181	67 651	81 754	86 632	112 693	128 969
Stone used to make cement	14 047	10 593	10 154	10 101	8 467	11 535	12 752
Stone used to make lime	1 626	3 411	3 446	4 260	5 137	3 556	2 925
Total	102 533	73 185	81 251	96 115	100 236	127 784	144 646
Fuels							
Coal	48 237	52 979	54 817	71 207	76 667	72 736	77 452
Total ore mined and rock quarried	522 243	412 513	410 828^{r}	485 426	493 581	522 901^{r}	556 765

[1] Excludes stone used to manufacture cement and lime in Canada.

^{r} Revised.

Note: Totals may not add due to rounding.

TABLE 60. CANADA, EXPLORATION AND CAPITAL EXPENDITURES IN THE MINING INDUSTRY[1] BY PROVINCES AND TERRITORIES, 1987–89

		Capital						Repair					
		Construction											
		On-property Exploration	On-property Development	Structures	Sub-total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	Outside or General Exploration	Total, all Expenditures
							($ million)						
Newfoundland	1987	(2)	68.9	(2)	151.7	18.1	169.8	(2)	(2)	117.4	287.2	28.4	315.6
	1988[p]	(2)	(2)	66.3	110.4	23.9	134.3	(2)	(2)	132.7	267.0	36.3	303.3
	1989[i]	(2)	36.8[r]	(2)	54.4[r]	37.8[r]	92.2[r]	(2)	(2)	120.1	212.3[r]	36.2	248.5[r]
Prince Edward Island	1987	–	–	–	–	–	–	–	–	–	–	–	–
	1988[p]	–	–	–	–	–	–	–	–	–	–	–	–
	1989[i]	–	–	–	–	–	–	–	–	–	–	–	–
Nova Scotia	1987	(2)	65.0	(2)	81.3	44.7	126.0	2.9	38.9	41.8	167.8	29.7	197.5
	1988[p]	–	23.1	5.1	28.2	51.5	79.7	1.7	31.8	33.5	113.2	52.8	166.0
	1989[i]	(2)[r]	30.5[r]	(2)[r]	36.5[r]	41.5[r]	78.0[r]	2.7	32.8	35.5	113.5[r]	37.4	150.9[r]
New Brunswick	1987	(2)	22.9	(2)	36.1	44.5	80.6	(2)	(2)	74.6	155.2	10.6	165.8
	1988[p]	(2)	(2)	8.4	37.9	32.7	70.6	(2)	(2)	81.7	152.3	19.7	172.0
	1989[i]	(2)[r]	35.8[r]	(2)[r]	48.0[r]	68.3[r]	116.3[r]	(2)	(2)	88.8	205.1[r]	20.0	225.1[r]
Quebec	1987	56.4	206.3	52.6	315.3	109.5	424.8	36.9	210.5	247.4	672.2	400.3	1 072.5
	1988[p]	40.0	163.7	56.9	260.6	94.4	355.0	27.2	222.5	249.7	604.7	336.7	941.4
	1989[i]	26.4[r]	199.9[r]	65.7[r]	292.0[r]	114.7[r]	406.7[r]	25.5	237.9	263.4	670.1[r]	195.2	865.3[r]
Ontario	1987	58.9	369.4	147.7	576.0	187.4	763.4	44.9	355.4	400.3	1 163.7	285.5	1 449.2
	1988[p]	34.8	344.6	107.2	486.6	333.1	819.7	67.4	414.2	481.6	1 301.3	304.4	1 605.7
	1989[i]	34.3[r]	309.7[r]	67.5[r]	411.5[r]	257.7[r]	669.2[r]	71.9	444.4	516.3	1 185.5[r]	219.6	1 405.1[r]
Manitoba	1987	10.1	34.4	26.7	71.2	22.3	93.5	(2)	(2)	46.9	140.5	32.4	172.8
	1988[p]	(2)	32.4	(2)	95.6	36.3	131.9	2.2	52.6	54.8	186.7	23.5	210.2
	1989[i]	6.1[r]	59.6[r]	37.1[r]	102.8[r]	22.5[r]	125.3[r]	2.3	50.3	52.6	177.9[r]	38.1	216.0[r]
Saskatchewan	1987	9.7	102.2	8.9	120.8	37.4	158.2	7.6	136.8	144.4	302.6	43.6	346.2
	1988[p]	(2)	99.9	(2)	139.9	65.9	205.8	10.5	127.8	138.3	344.1	73.4	417.5
	1989[i]	7.3[r]	99.7[r]	14.1[r]	121.1[r]	75.0[r]	196.1[r]	11.9	132.8	144.7	340.8[r]	72.1	412.9[r]
Alberta	1987	(2)	12.0	(2)	15.0	28.8	43.8	(2)	(2)	81.7	125.5	5.1	130.6
	1988[p]	(2)	13.6	(2)	26.2	30.9	57.1	0.7	89.9	90.6	147.7	5.9	153.6
	1989[i]	(2)	14.9[r]	(2)	16.7[r]	20.0[r]	36.7[r]	0.7	87.4	88.1	124.8[r]	7.7	132.5[r]
British Columbia	1987	10.2	249.2	65.1	324.5	116.5	441.0	17.0	388.2	405.2	846.2	133.2	979.4
	1988[p]	15.0	298.7	144.0	457.7	92.5	550.2	20.3	422.9	443.2	993.4	180.2	1 173.6
	1989[i]	9.4[r]	262.6[r]	114.8[r]	386.8[r]	177.4[r]	564.2[r]	27.2	429.9	457.1	1 021.3[r]	147.5[r]	1 168.8[r]
Yukon	1987	(2)	7.3	(2)	16.5	5.7	22.2	0.2	15.3	15.5	37.7	24.5	62.2
	1988[p]	(2)	8.5	(2)	27.1	10.8	37.9	0.2	19.4	19.6	57.5	28.3	85.8
	1989[i]	(2)[r]	21.6[r]	(2)	29.8[r]	2.3[r]	32.1[r]	(2)	(2)	16.2	48.3[r]	19.0[r]	67.3[r]
Northwest Territories	1987	5.0	20.2	16.8	42.0	9.6	51.8	2.7	45.0	47.7	99.5	54.6	154.1
	1988[p]	17.4	24.8	28.9	71.1	30.8	101.9	(2)	(2)	26.8	128.7	46.7	175.4
	1989[i]	(2)[r]	27.1[r]	(2)	97.9[r]	41.2[r]	139.1[r]	1.9	24.6	26.5	165.6[r]	39.3[r]	204.9[r]
Canada	1987	160.5	1 157.7	432.0	1 750.2	624.6	2 374.8	133.4	1 489.6	1 623.0	3 997.8	1 048.1	5 045.9
	1988[p]	138.7	1 071.6	530.7	1 741.0	802.7	2 543.7	146.6	1 606.2	1 752.8	4 296.5	1 107.9	5 404.4
	1989[i]	102.6[r]	1 098.3[r]	396.5[r]	1 597.4[r]	858.3[r]	2 455.7[r]	159.0	1 650.2	1 809.2	4 264.9[r]	832.2[r]	5 097.1[r]

[1] Excludes crude oil and natural gas industries. (2) Confidential, included in total.
[p] Preliminary; [i] Intentions; – Nil; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 61. CANADA, EXPLORATION AND CAPITAL EXPENDITURES[1] IN THE MINING INDUSTRY BY TYPE OF MINING, 1987–89

		Capital						Repair					
		Construction											
		On-property Exploration	On-property Development	Structures	Sub-total	Machinery and Equipment	Total Capital	Construction	Machinery and Equipment	Total Repair	Total Capital and Repair	Outside or General Exploration	Total, all Expenditures
							($ million)						
Metal Mines													
Copper-gold-silver	1987	24.8	87.5	40.0	152.3	66.9	219.2	26.1	240.3	266.4	485.6	14.0	499.6
	1988^p	12.1	112.4	139.8	264.3	78.4	342.7	16.7	249.4	266.1	608.8	10.2	619.0
	1989^i	13.6^r	104.3^r	75.1^r	193.0^r	101.6^r	294.6^r	17.4	266.0	283.4	578.0^r	12.1	590.1^r
Gold	1987	101.0	367.1	280.7	748.8	171.1	919.9	26.2	117.6	143.8	1 063.7	89.3	1 153.0
	1988^p	84.3	400.0	248.7	733.0	267.2	1 000.2	44.5	169.8	214.3	1 214.5	135.7	1 350.2
	1989^i	50.2^r	303.3^r	195.5^r	549.0^r	178.2^r	727.2^r	48.9	176.3	225.2	952.4^r	66.7	1 019.1^r
Iron	1987	(4)	95.1	(4)	100.1	20.3	120.4	8.4	192.3	200.7	321.1	0.2	321.3
	1988^p	(4)	59.6	(4)	76.8	22.0	98.8	10.3	219.3	229.6	328.4	0.7	329.1
	1989^i	(4)	56.7^r	(4)	66.4^r	41.6^r	108.0^r	9.1	202.0	211.1	319.1^r	(4)	(4)
Silver-lead-zinc	1987	10.5	60.9	24.0	95.4	35.3	130.7	14.5	99.0	113.5	244.2	21.2	265.4
	1988^p	14.7	44.7	17.0	76.4	38.0	114.4	9.8	91.7	101.5	215.9	22.2	238.1
	1989^i	9.2^r	110.2^r	27.7^r	147.1^r	65.1^r	212.2^r	10.3	92.5	102.8	315.0^r	24.0	339.0^r
Uranium	1987	8.3	82.6	5.7	96.6	16.1	112.7	(4)	(4)	119.7	232.4	28.4	260.8
	1988^p	(4)	68.1	(4)	91.4	36.1	127.5	10.0	126.7	136.7	264.2	33.3	297.5
	1989^i	(4)	78.8^r	(4)	93.6^r	30.9^r	124.5^r	9.6	137.8	147.4	271.9^r	41.3	313.2^r
Other metal mining[2]	1987	(4)	101.1	(4)	134.0	59.2	193.2	(4)	(4)	140.7	333.9	9.5	343.4
	1988^p	12.1	72.7	32.2	117.0	92.7	209.7	28.6	143.0	171.6	381.3	7.0	388.3
	1989^i	20.0^r	149.1^r	26.2^r	195.3^r	111.2^r	306.5^r	32.7	158.8	191.5	498.0^r	(4)	(4)
Total metal mining	1987	155.5	794.3	377.6	1 327.4	369.0	1 696.4	106.7	878.1	984.8	2 681.2	162.5	2 843.7
	1988^p	127.9	757.6	473.4	1 358.9	534.5	1 893.4	119.9	999.8	1 119.7	3 013.1	209.0	3 222.1
	1989^i	96.2^r	802.4^r	345.8^r	1 244.4^r	528.5^r	1 772.9^r	127.9	1 033.4	1 161.3	2 934.2^r	151.7	3 085.9^r
Nonmetal Mines													
Asbestos	1987	(4)	41.7	(4)	46.5	8.8	55.3	2.0	53.0	55.0	110.3	–	110.3
	1988^p	(4)	34.9	(4)	35.1	3.9	39.0	2.3	53.8	56.1	95.1	–	95.1
	1989^i	(4)	35.3^r	(4)	35.4^r	2.0^r	37.4^r	2.0	57.8	59.8	97.2^r	–	97.2^r
Coal	1987	1.6	216.4	21.4	239.4	88.8	328.2	10.1	312.4	322.5	650.7	10.1	660.8
	1988^p	(4)	188.3	(4)	204.6	115.9	320.5	11.4	329.3	340.7	661.2	11.7	672.9
	1989^i	(4)	175.2^r	(4)	180.3^r	136.2^r	316.5^r	13.2	325.5	338.7	655.2^r	9.9	665.1^r
Other nonmetal mining[3]	1987	(4)	105.2	(4)	135.8	154.2	290.0	11.4	243.4	254.8	544.8	2.7	547.5
	1988^p	8.7	90.8	40.1	139.6	144.1	283.7	12.7	219.0	231.7	515.4	4.3	519.7
	1989^i	3.6^r	85.5^r	45.5^r	134.6^r	173.3^r	307.9^r	15.7	229.0	244.7	552.6^r	3.1	555.7^r
Total nonmetal mining	1987	5.0	363.3	53.5	421.8	251.8	673.6	23.4	608.9	632.3	1 305.9	12.8	1 318.7
	1988^p	10.8	314.0	54.5	379.3	264.0	643.3	26.3	602.0	628.3	1 271.6	16.0	1 287.6
	1989^i	6.4^r	296.0^r	48.0^r	350.4^r	311.4^r	661.8^r	30.9	612.3	643.2	1 305.0^r	13.0	1 318.0^r
Metal and Nonmetal Exploration Companies	1987	–	–	1.0	1.0	3.9	4.9	3.3	2.7	6.0	10.9	872.8	883.7
	1988^p	–	–	2.8	2.8	4.2	7.0	0.4	4.3	4.7	11.7	882.9	894.6
	1989^i	–	–	2.7	2.7	18.4	21.1	0.2	4.4	4.6	25.7	667.5	693.2
Total mining	1987	160.5	1 157.7	432.0	1 750.2	624.6	2 374.8	133.4	1 489.6	1 623.0	3 997.8	1 048.1	5 045.9
	1988^p	138.7	1 071.6	530.7	1 741.0	802.7	2 543.7	146.6	1 606.2	1 752.8	4 296.5	1 107.9	5 404.4
	1989^i	102.6^r	1 098.3^r	396.5^r	1 597.4^r	858.3^r	2 455.7^r	159.0	1 650.2	1 809.2	4 264.9^r	832.2	5 097.1^r

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[1] Excludes expenditures in the petroleum and natural gas industries. [2] Includes nickel-copper mines, silver-cobalt mines and other metal mines. [3] Includes gypsum mines, salt mines, potash mines, quarries, sand and gravel pits and other nonmetal mines. (4) Confidential, included in total.

^{p} Preliminary, ^{i} Intentions, – Nil, ^{r} Revised

Note: Totals may not add due to rounding.

TABLE 62. CANADA, DIAMOND DRILLING IN THE MINING INDUSTRY BY MINING COMPANIES WITH OWN EQUIPMENT AND BY DRILLING CONTRACTORS, 1985–87

		1985			1986			1987		
		Exploration	Other	Total	Exploration	Other	Total	Exploration	Other	Total
						(metres)				
Metal mines										
Gold	Own equipment	51 906	22 642	74 548	50 003	161 919	211 922	36 101	49 276	85 377
	Contractors	349 405	5 612	355 017	553 141	9 833	562 974	565 311	–	565 311
	Total	401 311	28 254	429 565	603 144	171 752	774 896	601 412	49 276	650 688
Nickel-copper-zinc	Own equipment	228 851	–	228 851	185 156	11 568	196 724	154 123	–	154 123
	Contractors	246 731	–	246 731	237 601	–	237 601	349 386	–	349 386
	Total	475 582	–	475 582	422 757	11 568	434 325	503 509	–	503 509
Iron mines	Own equipment	–	203 876	203 876	15 000	199 336	214 336	15 000	226 782	241 782
	Contractors	5 295	–	5 295	3 900	–	3 900	6 771	–	6 771
	Total	5 295	203 876	209 171	18 900	199 336	218 236	21 771	226 782	248 553
Silver-lead-zinc	Own equipment	60 074	3 983	64 057	59 334	6 000	65 334	54 667	–	54 667
	Contractors	88 345	290	88 635	98 422	–	98 422	70 624	–	70 624
	Total	148 419	4 273	152 692	157 756	6 000	163 756	125 291	–	125 291
Uranium	Own equipment	41 659	–	41 659	37 661	–	37 661	30 619	49 485	80 104
	Contractors	12 827	–	12 827	233	–	233	11 718	–	11 718
	Total	54 486	–	54 486	37 894	–	37 894	42 337	49 485	91 822
Miscellaneous metal mining	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	22 707	400	23 107	22 512	–	22 512	18 636	–	18 636
	Total	22 707	400	23 107	22 512	–	22 512	18 636	–	18 636
Total metal mining	Own equipment	382 490	230 501	612 991	347 154	378 823	725 977	290 510	325 543	616 053
	Contractors	725 310	6 302	731 612	915 809	9 833	925 642	1 022 446	–	1 022 446
	Total	1 107 800	236 803	1 344 603	1 262 963	388 656	1 651 619	1 312 956	325 543	1 638 499
Nonmetal mines										
Gypsum	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	521	2 183	2 704	4 632	9 144	13 776	–	2 438	2 438
	Total	521	2 183	2 704	4 632	9 144	13 776	–	2 438	2 438
Other nonmetal mines	Own equipment	8 334[r]	–	8 334	1 710	–	1 710	–	–	–
	Contractors	3 064	–	3 064	1 430	4[r]	1 434[r]	2 154	–	2 154
	Total	11 398[r]	–	11 398	3 140	4[r]	3 144[r]	2 154	–	2 154
Asbestos	Own equipment	–	–	–	–	–	–	–	–	–
	Contractors	5 160	–	5 160	2 851	–	2 851	1 864	–	1 864
	Total	5 160	–	5 160	2 851	–	2 851	1 864	–	1 864
Potash	Own equipment	3 139	–	3 139	–	–	–	18 100	–	18 100
	Contractors	–	–	–	–	–	–	3 437	–	3 437
	Total	3 139	–	3 139	–	–	–	21 537	–	21 537
Total nonmetal mining	Own equipment	11 473	–	11 473	1 710	–	1 710	18 100	–	18 100
	Contractors	8 745	2 183	10 928	8 913	9 148[r]	18 061[r]	7 455	2 438	9 893
	Total	20 218	2 183	22 401	10 623	9 148[r]	19 771[r]	25 555	2 438	27 993
Total mining industry	Own equipment	393 963	230 501	624 464	348 864	378 823	727 687	308 610	325 543	634 153
	Contractors	734 055	8 485	742 540	924 722	18 981[r]	943 703[r]	1 029 901	2 438	1 032 339
	Total	1 128 018	238 986	1 367 004	1 273 586	397 804[r]	1 671 390[r]	1 338 511	327 981	1 666 492

[r] Revised. – Nil

Note: Totals may not add due to rounding

TABLE 63. CANADA, ORE MINED AND ROCK QUARRIED IN THE MINING INDUSTRY, 1958–87

	Metals	Industrial[1]	Coal	Total
		(million tonnes)		
1958	71.4	71.2		142.6
1959	89.9	82.2		172.1
1960	92.1	88.7		180.8
1961	90.1	96.7		186.8
1962	103.6	103.8		207.4
1963	112.7	120.4		233.1
1964	128.0	134.1		262.1
1965	151.0	146.5		297.5
1966	147.6	171.8		319.4
1967	169.1	177.5		346.6
1968	186.9	172.7		359.6
1969	172.0	178.8		350.8
1970	213.0	179.1		392.1
1971	211.5	185.8		397.3
1972	206.0	189.7		395.7
1973	274.9	162.6		437.4
1974	278.7	178.8		457.5
1975	264.2	158.7		422.9
1976	296.5	167.1		463.6
1977	299.5	205.2	33.8	538.5
1978	248.1	205.5	36.3	489.9
1979	274.8	200.1	39.8	514.6
1980	290.1	193.5	43.9	527.5
1981	301.5	172.5	48.2	522.2
1982	238.4	121.2	53.0	412.5
1983	219.0	137.0	54.8	410.8[r]
1984	246.4	167.8	71.2	485.4
1985	245.0	171.9	76.7	493.6
1986	256.0[r]	194.2	72.7	522.9[r]
1987	266.2	213.1	77.5	556.8

[1] Includes nonmetallic mineral mining and all stone quarried, including stone used to make cement and lime. From 1979 onwards, coverage includes miscellaneous nonmetal mines previously excluded.
[r] Revised.
Note: Totals may not add due to rounding.

TABLE 64. CANADA, TOTAL DIAMOND DRILLING, METAL DEPOSITS, 1958–87

	Gold Deposits	Copper–zinc and Nickel–copper Deposits	Silver–lead–zinc Deposits	Other Metal Bearing Deposits[1]	Total Metal Deposits
			(metres)		
1958	546 861	923 026	297 792	286 970	2 054 649
1959	558 160	1 110 664	282 088	383 471	2 334 383
1960	628 016	1 267 792	226 027	315 067	2 436 902
1961	595 180	1 128 091	255 101	221 079	2 199 451
1962	902 288	1 025 048	350 180	358 679	2 636 195
1963	529 958	977 257	288 204	148 703	1 944 122
1964	458 933	709 588	401 099	104 738	1 674 358
1965	440 020	779 536	331 294	275 917	1 826 767
1966	442 447	729 148	292 223	164 253	1 628 071
1967	391 347	947 955	230 182	120 350	1 689 834
1968	375 263	935 716	198 038	56 780	1 565 797
1969	274 410	923 452	197 670	109 592	1 505 124
1970	214 717	1 132 915	375 019	99 373	1 822 024
1971	193 291	1 089 103	308 798	83 851	1 675 043
1972	229 771	967 640	240 195	50 225	1 487 831
1973	243 708	713 134	185 946	57 730	1 200 518
1974	250 248	798 564	197 322	83 484	1 329 618
1975	216 158	532 991	184 203	97 971	1 031 323
1976	156 030	507 620	166 366	97 735	927 751
1977	175 643	515 780	213 279	124 329	2 039 031
1978	209 335	346 722	490 489	135 197	1 181 743
1979	198 955	437 562	131 032	150 018	917 567
1980	187 635	566 610	259 877	173 945	1 188 067
1981	306 197	675 712	478 754	170 369	1 631 032
1982	288 421	386 940	424 218	164 742	1 264 321
1983	352 218	512 745	269 659	97 661	1 232 283
1984	406 060	830 536	273 238[r]	281 661	1 791 495[r]
1985	429 565	475 582	152 692	286 764	1 344 603
1986	774 896	434 325	163 756	278 642	1 651 619
1987	650 688	503 509	125 291	359 011	1 638 499

[1] Includes iron, titanium, uranium, molybdenum and other metal deposits.

[r] Revised.

TABLE 65. CANADA, EXPLORATION DIAMOND DRILLING, METAL DEPOSITS, 1958–87

	Mining Companies with Own Personnel and Equipment	Diamond Drill Contractors	Total
		(metres)	
1958	237 133	1 200 625	1 437 758
1959	239 786	1 367 061	1 606 847
1960	268 381	1 409 416	1 677 797
1961	302 696	1 337 173	1 639 869
1962	167 214	1 748 023	1 915 237
1963	361 180	1 169 292	1 530 472
1964	143 013	1 072 985	1 215 998
1965	209 002	1 176 996	1 385 998
1966	163 379	1 044 860	1 208 239
1967	93 164	1 123 137	1 216 301
1968	159 341	990 690	1 150 031
1969	135 311	1 072 328	1 207 639
1970	62 147	1 228 061	1 290 208
1971	86 838	1 053 330	1 140 168
1972	251 651	839 753	1 091 404
1973	321 333	742 899	1 064 232
1974	357 823	892 557	1 250 380
1975	346 770	618 161	964 931
1976	335 919	532 036	867 955
1977	327 241	638 327	965 568
1978	237 250	534 557	771 807
1979	311 221	571 721	882 942
1980	347 829	747 566	1 095 395
1981	460 687	917 566	1 378 253
1982	289 901	713 413	1 003 314
1983	324 383	707 343	1 031 726
1984	357 680	936 459	1 294 139
1985	382 490	725 310	1 107 800
1986	347 154	915 809	1 262 963
1987	290 510	1 022 446	1 312 956

TABLE 66. CANADA, DIAMOND DRILLING, OTHER THAN FOR EXPLORATION, METAL DEPOSITS, 1958–87

	Mining Companies with Own Personnel and Equipment	Diamond Drill Contractors	Total
		(metres)	
1958	444 376	172 516	616 892
1959	488 783	238 753	727 536
1960	450 246	308 860	759 106[r]
1961	384 432	175 149	559 581
1962	528 700	192 259	720 959
1963	388 228	25 422	413 650
1964	385 765	72 594	458 359
1965	393 947	46 822	440 769
1966	227 968	191 863	419 831
1967	186 463	287 071	473 534
1968	122 851	292 914	415 765
1969	87 552	209 933	297 485
1970	290 363	241 453	531 816
1971	295 966	238 910	534 876
1972	304 523	91 903	396 426
1973	77 162	59 124	136 286
1974	54 353	24 885	79 238
1975	31 917	34 475	66 392
1976	31 413	28 383	59 796
1977	24 303	39 160	63 463
1978	351 344	58 592	409 936
1979	4 090	30 535	34 625
1980	20 545	72 127	92 672
1981	200 898	51 881	252 779
1982	188 674	72 333	261 007
1983	81 138	119 419	200 557
1984	492 939[r]	4 417	497 356[r]
1985	230 501	6 302	236 803
1986	378 823	9 833	388 656
1987	325 543	–	325 543

[r] Revised; – Nil.

Note: Nonproducing companies excluded since 1964.

TABLE 67. CANADA, CRUDE MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1985–87

	1985	1986	1987
		(kilotonnes)	
Metallic minerals			
Iron ores and concentrates	39 197	36 688	36 093
Nickel-copper ores and concentrates	4 161	4 084	3 797
Alumina and bauxite	3 227	3 503	3 363
Zinc ores and concentrates	1 452	993	1 380
Copper ores and concentrates	1 467	1 357	1 356
Lead ores and concentrates	604	912	514
Metallic ores and concentrates, n.e.s.	73	10	4
Nickel ores and concentrates	–	–	–
Total metallic minerals	50 181	47 547	46 509
Nonmetallic minerals			
Potash (KC1)	9 891	10 266	11 577
Sulphur, n.e.s.	6 355	5 831	5 731
Gypsum	5 492	5 512	5 636
Limestone, n.e.s.	2 312	2 997	3 301
Phosphate rock	1 838	1 612	1 162
Sulphur, liquid	1 529	839	970
Sand, industrial	879	888	948
Clay	632	790	750
Salt, rock	650	799	687
Sodium carbonate	485	560	663
Limestone, industrial	418	455	386
Sodium sulphate	386	385	319
Nepheline syenite	241	242	252
Stone, n.e.s.	70	57	196
Salt, n.e.s.	101	101	146
Nonmetallic minerals, n.e.s.	181	177	142
Limestone, agricultural	85	128	93
Sand, n.e.s.	321	227	47
Silica	11	14	21
Abrasives, natural	20	17	21
Barite	13	14	12
Asbestos	81	31	11
Peat and other mosses	22	10	2
Total nonmetallic minerals	32 013	31 951	33 072
Mineral fuels			
Coal, bituminous	41 539	40 386	39 051
Coal, lignite	1 336	1 236	2 549
Coal, n.e.s.	54	63	949
Natural gas and other crude bituminous substances	37	31	43
Oil, crude	5	8	7
Total mineral fuels	42 971	41 724	42 599
Total crude minerals	125 165	121 223	122 180
Total revenue freight moved by Canadian railways	250 608	249 786	261 406
Percent crude minerals of total revenue freight	49.9	48.5	46.7

n.e.s. Not elsewhere specified; – Nil.

TABLE 68. CANADA, FABRICATED MINERAL PRODUCTS TRANSPORTED BY CANADIAN RAILWAYS, 1985–87

	1985	1986	1987
		(kilotonnes)	
Metallic minerals products			
Ferrous mineral products			
Iron and steel scrap	2 533	1 926	1 982
Sheets and strips, steel	1 072	829	1 140
Ingots, blooms, billets, slabs of iron and steel	907	804	659
Bars and rods, steel	715	683	648
Structural shapes and sheet piling, iron and steel	495	523	451
Plates, steel	426	350	311
Pipes and tubes, iron and steel	334	190	177
Rails and railway track material	59	62	70
Pig iron	22	59	68
Castings and forgings, iron and steel	106	94	67
Ferroalloys	43	48	37
Other primary iron and steel	29	33	23
Wire, iron or steel	8	10	5
Total ferrous mineral products	6 749	5 611	5 639
Nonferrous mineral products			
Aluminum and aluminum alloy fabricated material, n.e.s.	889	1 041	888
Zinc and alloys	536	483	433
Copper and alloys, n.e.s.	407	401	408
Aluminum paste, powder, pigs, ingots, shot	273	457	315
Other nonferrous base metals and alloys	177	205r	123
Lead and alloys	170	143	116
Nonferrous metal scrap	98	86	104
Slag, dross, etc	99	55	60
Copper matte and precipitates	4	4	1
Total nonferrous mineral products	2 653	2 875r	2 449
Total metallic mineral products	9 402	8 486r	8 088
Nonmetallic mineral products			
Fertilizers and fertilizer materials, n.e.s.	1 815	2 143	2 470
Portland cement, standard	1 687	1 665	1 873
Sulphuric acid	1 422	1 490	1 471
Gypsum basic products, n.e.s.	254	357	426
Nonmetallic mineral basic products, n.e.s.	224	197	210
Cement and concrete basic products, n.e.s.	164	258	208
Natural stone basic products, chiefly structural	160	172	185
Lime, hydrated and quick	139	104	177
Bricks and tiles, clay	12	18	104
Dolomite and magnesite, calcined	77	76	48
Glass basic products	47	40	43
Fire brick and similar shapes	28	23	23
Asbestos and asbestos-cement basic products	3	5	17
Refractories, n.e.s.	5	10	9
Plaster	9	5	6
Total nonmetallic mineral products	6 046	6 563	7 268
Mineral fuel products			
Refined and manufactured gases, fuel type	2 825	2 333	2 355
Diesel fuel	1 690	1 430	1 269
Gasoline	1 077	949	897
Fuel oil, n.e.s.	680	725	677
Coke, n.e.s.	672	732	633
Other petroleum and coal products	701	685	606
Petroleum coke	521	408	341
Lubricating oils and greases	337	312	308
Asphalts and road oils	374	347	284
Total mineral fuel products	8 877	7 922	7 371
Total fabricated mineral products	24 325	22 971r	22 727
Total revenue freight moved by Canadian railways	250 608	249 786	261 406
Fabricated mineral products as a percentage of total revenue freight	9.7	9.2r	8.7

n.e.s. Not elsewhere specified; r Revised.

TABLE 69. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED BY CANADIAN RAILWAYS, 1958–87

	Total Revenue Freight	Total Crude Minerals	Total Fabricated Minerals	Total Crude and Fabricated Minerals	Crude and Fabricated Minerals as Percent of Revenue Freight
			(million tonnes)		
1958	139.2	52.4	15.2	67.6	48.6
1959	150.6	68.2	15.3	78.1	51.9
1960	142.8	57.1	14.5	71.6	50.1
1961	138.9	54.1	13.6	67.7	48.7
1962	146.0	60.3	13.8	74.1	50.8
1963	154.6	62.9	15.5	78.4	50.6
1964	180.0	74.6	15.9	90.5	50.3
1965	186.2	80.9	17.3	98.2	52.7
1966	194.5	80.6	17.8	98.4	50.6
1967	190.0	81.2	17.7	98.9	52.1
1968	195.4	86.7	18.8	105.5	54.0
1969	189.0	81.9	27.6	109.5	57.9
1970	211.6	97.5	28.4	125.9	59.5
1971	214.5	95.6	27.4	123.0	57.3
1972	215.8	89.4	27.6	117.0	54.2
1973	241.2	113.1	29.1	142.2	59.0
1974	246.3	115.3	30.9	146.2	59.4
1975	226.0	110.6	26.6	137.2	60.7
1976	238.5	116.6	25.5	142.1	59.6
1977	247.2	121.1	25.7	146.8	59.4
1978	238.8	107.7	26.2	133.9	56.1
1979	257.9	127.2	26.6	153.8	59.6
1980	254.4	124.8	24.6	149.4	58.7
1981	246.6	120.7	26.4	147.1	59.7
1982	212.5	95.7	21.0	116.7	54.9
1983	222.8	95.3	22.7	118.0	53.0
1984	254.6	121.1	25.1	146.2	57.4
1985	250.6	125.2	24.3	149.5	59.7
1986	249.8	121.2	23.0[r]	144.2	57.7
1987	261.4	122.2	22.7	144.9	55.4

[r] Revised.

TABLE 70. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY[1], 1986–88

	Montreal – Lake Ontario Section			Welland Canal Section		
	1986	1987	1988	1986	1987	1988
			(tonnes)			
Crude minerals						
Iron ore	8 026 080	9 557 376	10 810 682	5 839 484	6 180 641	7 083 883
Coal	609 619	233 756	712 945	5 775 521	5 644 283	7 029 061
Salt	874 520	928 559	1 027 602	1 882 656	1 766 446	1 672 709
Other crude minerals	1 008 788	1 176 688	1 000 802	588 905	731 820	601 526
Stone, ground or crushed	271 945	231 637	432 370	1 005 726	889 303	992 668
Potash	192 435	55 098	294 948	262 357	83 312	372 971
Aluminum ores and concentrates	196 830	169 584	230 356	175 508	136 984	218 960
Clay and bentonite	161 366	164 766	240 823	161 366	164 766	240 823
Sand and gravel	16 009	–	–	82 436	89 372	226 492
Stone, rough	203	21	41	182	–	15 021
Phosphate rock	28 730	47 223	2 833	–	–	–
Total crude minerals	11 386 525	12 564 708	14 753 402	15 774 141	15 686 927	18 454 114
Fabricated mineral products						
Iron and steel, manufactured	2 922 806	2 633 980	2 724 806	2 385 475	2 197 601	2 327 939
Coke	867 412	654 432	1 466 718	993 268	822 061	1 638 341
Scrap iron and steel	740 276	344 352	369 397	782 966	372 318	364 658
Fuel oil	641 156	481 049	879 438	603 625	569 051	669 756
Iron and steel, bars, rods, slabs	615 469	972 396	1 581 257	455 565	469 961	697 850
Cement	152 616	242 758	32 101	347 060	549 874	488 672
Gasoline	206 107	167 472	248 120	186 564	97 982	126 537
Other petroleum products	110 263	181 447	141 952	114 252	136 429	141 004
Pig iron	96 925	124 355	93 248	71 730	104 815	82 921
Tar, pitch and creosote	39 222	22 946	27 104	54 810	49 030	62 830
Lubricating oils and greases	25 850	59 826	28 218	15 290	27 119	18 544
Iron and steel, nails, wire	10 527	8 027	10 670	9 030	6 951	8 396
Total fabricated minerals	6 428 629	5 893 040	7 603 029	6 019 635	5 403 192	6 627 448
Total crude and fabricated minerals	17 815 154	18 457 748	22 356 431	21 793 776	21 090 119	25 081 562
Total, all products	37 581 808	39 968 615	40 557 669	41 612 770	42 724 755	43 536 317
Crude and fabricated minerals as a percent of total	47.4	46.2	55.1	52.4	49.4	57.6

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[1] Total cargo transported regardless of travel direction.

– Nil

TABLE 71. CANADA, CRUDE AND FABRICATED MINERALS TRANSPORTED THROUGH THE ST. LAWRENCE SEAWAY[1], 1959–88

	Montreal – Lake Ontario Section				Welland – Canal Section			
	Total All Products	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percent of All Products	Total All Products	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percent of All Products
		(kilotonnes)				(kilotonnes)		
1959	19 252	7 725	2 197	51.5	24 953	12 117	2 246	57.6
1960	18 460	5 760	2 904	46.9	26 563	12 679	2 606	57.5
1961	21 212	6 706	2 358	42.7	28 490	12 599	2 378	52.7
1962	23 271	7 531	2 522	43.2	32 215	15 625	2 342	55.8
1963	28 198	9 507	2 804	43.7	37 490	18 094	2 524	55.0
1964	35 701	13 127	3 558	46.7	46 644	23 489	3 095	57.0
1965	39 352	13 788	6 024	50.3	48 477	23 555	4 933	58.8
1966	44 538	16 376	6 340	51.0	53 648	25 712	5 329	57.8
1967	39 918	17 800	6 430	60.7	47 945	26 010	5 459	65.6
1968	43 496	19 312	8 425	63.8	52 712	29 075	7 587	69.6
1969	37 256	12 682	8 263	56.2	48 601	25 090	6 715	65.4
1970	46 445	15 554	8 932	52.7	57 121	27 233	7 156	60.2
1971	48 069	14 204	9 263	48.8	57 205	23 903	7 914	55.6
1972	48 607	13 425	9 837	47.9	58 146	24 808	7 701	55.9
1973	52 285	17 111	9 639	51.1	60 958	26 907	7 718	56.8
1974	40 049	16 137	7 018	57.8	47 500	23 952	5 437	61.9
1975	43 554	15 698	6 071	50.0	53 387	26 100	5 129	58.5
1976	49 348	20 884	7 181	56.9	58 368	29 914	6 323	62.1
1977	57 456	23 008	9 918	57.3	65 079	30 459	8 933	60.5
1978	51 658	15 057	8 558	45.7	59 576	22 700	7 759	51.1
1979	50 187	16 408	8 104	48.8	60 023	24 851	7 940	54.6
1980	42 142	12 248	6 009	43.3	54 074	20 487	5 405	57.9
1981	45 876	15 453	5 711	46.1	53 389	22 132	5 529	51.8
1982	38 841	9 146	4 997	36.4	44 474	15 057	4 333	45.9
1983	45 061	12 443	5 422	39.6	50 145	17 412	5 618	45.9
1984	47 505	14 009	6 980	44.2	53 917	20 312	7 052	50.8
1985	37 322	11 689	6 152	47.8	41 852	16 203	6 127	53.4
1986	37 582	11 387	6 429	47.4	41 613	15 774	6 020	52.4
1987	39 969	12 565	5 893	46.2	42 725	15 687	5 403	49.4
1988	40 558	14 753	7 603	55.1	43 536	18 454	6 627	57.6

[1] Total cargo transported regardless of travel direction

TABLE 72. CANADA, CRUDE MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1988

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
				(tonnes)				
Metallic minerals								
Iron ore and concentrates	6 448 889	183 875	4 945	6 637 709	847 854	5 784 910	4 945	6 637 709
Titanium ore	2 438 766	–	–	2 438 766	2 430 308	8 458	–	2 438 766
Other metal ores, concentrates and scrap	12 767	105 724	1 905	120 396	32	118 459	1 905	120 396
Zinc bearing ore and concentrates	–	–	6 441	6 441	–	–	6 441	6 441
Lead in ores and concentrates	4 184	–	–	4 184	4 184	–	–	4 184
Total metals	8 904 606	289 599	13 291	9 207 496	3 282 378	5 911 827	13 291	9 207 496
Nonmetallic minerals								
Limestone	190	3 110 756	1 875 794	4 986 740	75 508	3 035 438	1 875 794	4 986 740
Salt	1 153 785	1 494 108	7 711	2 655 604	1 856 057	791 836	7 711	2 655 604
Sand and gravel	223 162	187 595	863 236	1 273 993	223 162	187 595	863 236	1 273 993
Gypsum	955 223	–	19 826	975 049	680 699	274 524	19 826	975 049
Other crude nonmetallic minerals, n.e.s.	11 812	234 682	269	246 763	194 644	51 850	269	246 763
Stone, crude, n.e.s.	55 942	182 017	–	237 959	55 942	182 017	–	237 959
Quartz-silica	44 702	77 617	77	122 396	–	122 319	77	122 396
Potash	–	99 672	–	99 672	16 980	82 692	–	99 672
Sulphur, crude and refined	8 021	–	399	8 420	8 021	–	399	8 420
Total nonmetals	2 452 837	5 386 447	2 767 312	10 606 596	3 111 013	4 728 271	2 767 312	10 606 596
Mineral fuels								
Coal and peat for fuel	322 937	2 622 918	115 857	3 061 712	322 937	2 622 918	115 857	3 061 712
Petroleum, crude	449 176	–	–	449 176	449 176	–	–	449 176
Total mineral fuels	772 113	2 622 918	115 857	3 510 888	772 113	2 622 918	115 857	3 510 888
Total crude minerals	12 129 556	8 298 964	2 896 460	23 324 980	7 165 504	13 263 016	2 896 460	23 324 980
Total all commodities	21 344 623	22 625 251	26 004 153	69 974 027	2 5745 034	18 241 495	25 987 498	69 974 027
Crude minerals as a percent of all commodities	56.8	36.7	11.1	33.3	27.8	72.7	11.1	33.3

– Nil; n.e.s. Not elsewhere specified.
Note: Totals may not add due to rounding.

TABLE 73. CANADA, FABRICATED MINERALS LOADED AND UNLOADED IN COASTWISE SHIPPING, 1988

	Loaded				Unloaded			
	Atlantic	Great Lakes	Pacific	Total	Atlantic	Great Lakes	Pacific	Total
				(tonnes)				
Metallic mineral products								
Ferrous mineral products								
Structural shapes, iron and steel	3 434	160 093	51 097	214 624	3 434	160 093	51 097	214 624
Plates and sheets, steel	116	59 654	–	59 770	116	59 654	–	59 770
Primary iron, steel	15 476	–	2 268	17 744	–	15 476	2 268	17 744
Castings and forgings, steel	–	–	9 707	9 707	–	–	9 707	9 707
Pipes and tubes, iron and steel	1 269	609	–	1 878	1 269	609	–	1 878
Rails and railway track material	1 456	–	–	1 456	1 456	–	–	1 456
Bars and rods, steel	783	–	–	783	782	–	–	782
Wire, iron and steel	602	–	–	602	602	–	–	602
Aluminum and aluminum products	153 335	–	–	153 335	153 335	–	–	153 335
Total metallic mineral products	176 471	220 356	63 072	459 899	160 994	235 832	63 072	459 898
Nonmetallic mineral products								
Cement	12 704	759 374	78 581	850 659	5 129	766 949	78 581	850 659
Cement basic products	330	–	25 251	25 581	331	–	25 251	25 582
Sulphuric acid	–	–	11 675	11 675	–	–	11 675	11 675
Other nonmetallic mineral products	11 594	–	–	11 594	11 593	–	–	11 593
Bricks, tiles and pipes, clay	3 169	71	–	3 240	3 169	71	–	3 240
Fertilizers and fertilizer material, n.e.s.	1 434	–	–	1 434	1 435	–	–	1 435
Glass basic products	243	–	–	243	243	–	–	243
Total nonmetals	29 474	759 445	115 507	904 426	21 900	767 020	115 507	904 427
Mineral fuel products								
Fuel oil	4 212 812	1 029 701	1 088 995	6 331 508	4 531 814	710 832	1 088 862	6 331 508
Gasoline	2 452 600	387 564	526 603	3 366 767	2 431 370	409 279	526 119	3 366 768
Asphalts and road oils	232 094	49 520	–	281 614	177 924	103 690	–	281 614
Petroleum coke	31 648	145 609	91	177 348	166 281	10 976	91	177 348
Other petroleum and coal products	98 834	47 294	–	146 128	114 587	31 542	–	146 129
Lubricating oils and greases	7 769	–	138	7 907	880	6 889	138	7 907
Total mineral fuel products	7 035 757	1 659 688	1 615 827	10 311 272	7 422 856	1 273 208	1 615 210	10 311 274
Total fabricated mineral products	7 241 702	2 639 489	1 794 406	11 675 597	7 605 750	2 276 060	1 793 789	11 675 599
Total all commodities	21 344 623	22 625 251	26 004 153	69 974 027	25 745 034	18 241 495	25 987 498	69 974 027
Fabricated mineral products as a percent of all commodities	33.9	11.7	6.9	16.7	29.5	12.5	6.9	16.7

– Nil; n.e.s. Not elsewhere specified
Note: Totals may not add due to rounding

TABLE 74. CANADA, CRUDE AND FABRICATED MINERALS LOADED AT CANADIAN PORTS IN COASTWISE SHIPPING, 1959–88

	Total All Commodities	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percent of All Products
		(kilotonnes)		
1959	36 494	9 984	7 819	48.8
1960	37 058	8 786	8 229	45.9
1961	41 861	9 527	8 857	43.9
1962	39 763	8 361	9 768	45.6
1963	40 328	7 998	9 942	44.5
1964	47 171	8 522	11 194	41.8
1965	48 200	9 183	11 766	43.5
1966	55 122	10 155	12 653	41.4
1967	49 799	11 509	12 207	47.6
1968	50 921	13 698	13 245	52.9
1969	51 890	12 746	14 181	51.9
1970	57 301	14 415	14 818	51.0
1971	55 128	14 783	15 374	54.7
1972	55 326	14 197	15 290	53.3
1973	55 314	16 573	15 615	58.2
1974	53 633	11 723	16 575	52.8
1975	54 373	15 687	17 510	61.1
1976	53 882	15 924	16 208	59.6
1977	58 309	18 131	17 435	61.0
1978	60 668	18 318	16 619	57.6
1979	79 950	22 130	17 486	49.6
1980	82 761	22 947	17 134	48.4
1981	71 271	17 849	16 669	48.4
1982	65 881	16 473	13 214	45.1
1983	67 598	21 248	12 025	49.2
1984	68 698	22 798	11 909	50.5
1985	61 717	19 867	10 291	48.9
1986	60 506	19 901	10 264	49.9
1987	67 572	20 969	11 118	47.5
1988	69 974	23 325	11 676	50.0

TABLE 75. CANADA, CRUDE MINERALS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1986–88

	1986		1987		1988	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Metallic minerals						
Iron ore and concentrates	30 488 690	6 177 384	31 002 238	6 716 664	32 879 255	6 419 164
Other nonferrous ores, concentrates and metal scrap, n.e.s.	1 391 039	346 100	1 342 230	252 384	1 798 622	279 629
Zinc ore and concentrates	645 143	403	994 894	629	1 276 705	605
Copper ores and concentrates	1 359 875	92 763	1 601 356	155 112	1 271 805	158 305
Lead ore and concentrates	85 068	11 446	132 778	2 158	90 179	7 587
Alumina, bauxite ore	27 216	3 832 453	27 726	3 599 494	22 707	4 486 281
Titanium ore	(2)	(2)	(2)	(2)	(2)	(2)
Manganese ore	(2)	(2)	(2)	(2)	(2)	(2)
Nickel ore and concentrates	(1)	(1)	(1)	(1)	(1)	(1)
Total metals	33 997 301	10 463 549	35 101 222	10 726 441	37 339 273	11 351 571
Nonmetallic minerals						
Potash	5 755 702	59 934	6 426 820	283 583	7 654 867	250 170
Sulphur	5 773 129	42 001	5 920 979	–	6 437 171	–
Gypsum	5 781 273	177 148	5 433 907	189 915	5 963 134	285 164
Salt	2 222 807	1 227 792	2 067 309	906 523	2 725 945	1 085 842
Crude nonmetallic minerals, n.e.s.	1 248 437	1 411 552	1 915 122	1 317 368	1 741 111	1 506 828
Limestone	1 114 655	1 232 261	1 421 705	1 188 278	1 667 478	1 003 680
Clay materials, n.e.s.	716 438	345 832	571 612	249 559	825 121	444 385
Asbestos	491 951	1 241	505 591	1 845	578 507	294
Sand and gravel	295 493	1 321 022	408 707	1 395 557	347 789	1 273 376
Phosphate rock	25 590	1 602 018	3 328	1 661 378	–	1 797 371
Bentonite	(4)	(4)	(4)	(4)	(4)	(4)
China clay	(4)	(4)	(4)	(4)	(4)	(4)
Dolomite	(3)	(3)	(3)	(3)	(3)	(3)
Stone, crude, n.e.s.	(3)	(3)	(3)	(3)	(3)	(3)
Stone, crushed	(3)	(3)	(3)	(3)	(3)	(3)
Fluorspar	(3)	(3)	(3)	(3)	(3)	(3)
Barite	(3)	(3)	(3)	(3)	(3)	(3)
Total nonmetals	23 425 475	7 420 801	24 675 080	7 194 006	27 941 123	7 647 110
Mineral fuels						
Coal, bituminous	25 986 381	13 589 832	25 324 002	14 334 318	31 604 994	17 777 159
Petroleum, crude	1 306 998	12 414 057	980 908	14 810 357	2 033 662	17 646 741
Fuels, n.e.s.	3 401	37	3 734	–	14 658	3
Total fuels	27 296 780	26 003 926	26 308 644	29 144 675	33 653 314	35 423 903
Total crude minerals	84 719 556	43 888 276	86 084 946	47 065 122	98 933 710	54 422 584
Total all commodities	144 560 692	62 011 827	158 993 861	68 025 360	171 064 410	78 911 838
Crude minerals as a percent of all commodities	58.6	70.8	54.1	69.2	57.8	69.0

(1) Included with "Copper ores and concentrates." (2) Included with "Other nonferrous ores, concentrates and metal scrap, n.e.s." (3) Included with "Crude nonmetallic minerals, n.e.s." (4) Included with "Clay materials, n.e.s."
– Nil; n.e.s. Not elsewhere specified.

TABLE 76. CANADA, FABRICATED MINERAL PRODUCTS LOADED AND UNLOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1986–88

	1986		1987		1988	
	Loaded	Unloaded	Loaded	Unloaded	Loaded	Unloaded
			(tonnes)			
Metallic products						
Iron and steel, other	1 024 616	1 833 389	1 238 605	2 373 878	1 005 743	3 333 003
bars and rods	(1)	(1)	(1)	(1)	(1)	(1)
castings and forgings	(1)	(1)	(1)	(1)	(1)	(1)
pipes and tubes	(1)	(1)	(1)	(1)	(1)	(1)
plates and sheets	(1)	(1)	(1)	(1)	(1)	(1)
rails and track material	(1)	(1)	(1)	(1)	(1)	(1)
structural shapes	(1)	(1)	(1)	(1)	(1)	(1)
wire and rope	(1)	(1)	(1)	(1)	(1)	(1)
Nonferrous metals, n.e.s.	716 950	171 168	536 826	243 882	696 619	326 824
Copper and alloys	(2)	(2)	(2)	(2)	(2)	(2)
Aluminum	(2)	(2)	(2)	(2)	(2)	(2)
Zinc and alloys	(2)	(2)	(2)	(2)	(2)	(2)
Ferroalloys	(2)	(2)	(2)	(2)	(2)	(2)
Nickel and alloys	(2)	(2)	(2)	(2)	(2)	(2)
Lead and alloys	(2)	(2)	(2)	(2)	(2)	(2)
Iron, pig	(1)	(1)	(1)	(1)	(1)	(1)
Iron and steel, primary	(1)	(1)	(1)	(1)	(1)	(1)
Total metals	1 741 566	2 004 557	1 775 431	2 617 760	1 702 362	3 659 827
Nonmetallic minerals						
Cement	1 849 287	410 446	1 875 476	515 100	1 579 898	778 713
Nonmetallic mineral basic products	130 378	353 237	289 902	389 752	112 017	468 563
Building blocks, n.e.s.	(4)	(4)	(4)	(4)	(4)	(4)
Fertilizers, n.e.s.	(4)	(4)	(4)	(4)	(4)	(4)
Asbestos basic products	(4)	(4)	(4)	(4)	(4)	(4)
Sulphuric acid	(4)	(4)	[illegible]	(4)	(4)	(4)
Glass basic products	(4)	(4)	(4)	(4)	(4)	(4)
Cement basic products	(3)	(3)	(3)	(3)	(3)	(3)
Total nonmetals	1 979 665	763 683	2 165 378	904 852	1 691 915	1 247 276
Mineral fuel products						
Fuel oil	2 848 642	3 365 556	3 512 047	4 104 047	5 861 422	5 249 818
Gasoline	1 401 743	689 495	1 489 372	1 108 892	2 329 522	905 923
Coke	199 641	1 225 264	1 180 208	1 231 270	353 210	1 739 797
Petroleum and coal products, n.e.s.	131 530	310 045	365 073	783 366	288 917	694 674
Asphalts, road oils	(5)	(5)	(5)	(5)	(5)	(5)
Lubricating oils and greases	(5)	(5)	(5)	(5)	(5)	(5)
Coal tar, pitch	(5)	(5)	(5)	(5)	(5)	(5)
Total fuels	4 581 556	5 590 360	6 546 700	7 227 575	8 833 071	8 590 212
Total fabricated mineral products	8 302 787	8 358 600	10 487 509	10 750 187	12 227 348	13 497 315
Total all commodities	144 560 692	62 011 827	158 993 861	68 025 360	171 064 410	78 911 838
Fabricated mineral products as a percent of all commodities	5.7	13.5	6.6	15.8	7.1	17.1

(1) Included with "Iron and steel, other." (2) Included with "Nonferrous metals, n.e.s." (3) Included with "Cement." (4) Included with "Nonmetallic mineral basic products." (5) Included with "Petroleum and coal products, n.e.s."
n.e.s. Not elsewhere specified.

TABLE 77. CANADA, CRUDE AND FABRICATED MINERALS LOADED AT CANADIAN PORTS IN INTERNATIONAL SHIPPING TRADE, 1959–88

	Total All Commodities	Total Crude Minerals	Total Fabricated Minerals	Crude and Fabricated Minerals as Percent of All Products
	(kilotonnes)			
1959	45 872	25 789	1 619	59.9
1960	45 872	24 671	2 039	58.2
1961	48 771	23 241	2 133	52.0
1962	54 676	30 446	2 296	59.9
1963	62 031	32 214	2 503	56.0
1964	75 760	42 087	2 602	59.0
1965	74 521	41 338	2 746	59.2
1966	76 192	41 374	3 350	58.7
1967	72 598	42 704	3 701	63.9
1968	78 663	48 680	2 960	65.6
1969	70 432	42 442	3 456	65.1
1970	95 807	55 849	4 965	68.5
1971	95 887	53 245	5 022	60.7
1972	98 988	51 912	9 091	61.6
1973	112 434	64 195	10 103	66.1
1974	106 110	64 093	9 041	68.9
1975	102 444	61 970	7 495	67.8
1976	114 815	71 527	6 108	67.6
1977	119 770	70 257	5 979	63.7
1978	116 522	62 291	7 556	59.9
1979	134 639	79 685	8 901	65.8
1980	138 161	67 898	11 770	57.7
1981	145 445	83 007	9 022	63.3
1982	125 282	65 594	7 115	58.1
1983	129 490	67 152	6 197	56.7
1984	145 322	82 752	7 986	62.4
1985	143 421	83 878	10 814	66.0
1986	144 561	84 720	8 303	64.3
1987	158 994	86 085	10 488	60.7
1988	171 064	98 934	12 227	65.0

TABLE 78. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINING INDUSTRY[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1985[r]

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Metal mines												
Reporting corporations												
Canadian	197	84.9	21 438	80.4	10 257	82.3	7 120	70.4	114	115.2	247	66.4
Foreign	35	15.1	5 218	19.6	2 211	17.7	2 993	29.6	-15	-15.2	125	33.6
Total	232	100.0	26 656	100.0	12 468	100.0	10 113	100.0	99	100.0	372	100.0
Mineral fuels												
Reporting corporations												
Canadian	2 313	91.4	51 932	62.4	19 856	57.1	13 574	42.1	3 058	32.4	1 329	20.3
Foreign	219	8.6	31 291	37.6	14 900	42.9	18 703	57.9	6 370	67.6	5 216	79.7
Total	2 532	100.0	83 223	100.0	34 756	100.0	32 277	100.0	9 428	100.0	6 545	100.0
Other mining (including mining services)												
Reporting corporations												
Canadian	5 047	96.3	8 946	73.9	3 949	75.7	4 182	69.2	-57	50.0	239	50.1
Foreign	195	3.7	3 167	26.1	1 271	24.3	1 860	30.8	-57	50.0	238	49.9
Total	5 242	100.0	12 113	100.0	5 220	100.0	6 042	100.0	-114	100.0	477	100.0
Total mining												
Reporting corporations												
Canadian	7 557	94.4	82 316	67.5	34 062	64.9	24 876	51.4	3 115	33.1	1 815	24.5
Foreign	449	5.6	39 676	32.5	18 382	35.1	23 556	48.6	6 298	66.9	5 579	75.5
Total	8 006	100.0	121 992	100.0	52 444	100.0	48 432	100.0	9 413	100.0	7 394	100.0

[1] Cement, lime and clay products (domestic clay) are included in mineral manufacturing industries. [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

[r] Revised

Note. Totals may not add due to rounding.

TABLE 78a. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINING INDUSTRY[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1986p

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Metal mines												
Reporting corporations												
Canadian	172	83.5	23 333	82.1	11 082	83.1	6 669	70.5	207	48.7	156	61.9
Foreign	34	16.5	5 096	17.9	2 252	16.9	2 791	29.5	218	51.3	96	38.1
Total	206	100.0	28 429	100.0	13 334	100.0	9 460	100.0	425	100.0	252	100.0
Mineral fuels												
Reporting corporations												
Canadian	2 343	91.6	46 533	63.0	16 913	56.6	9 840	49.7	-3 295	161.8	560	29.5
Foreign	216	8.4	27 382	37.0	12 966	43.4	9 961	50.3	1 259	-61.8	1 341	70.5
Total	2 559	100.0	73 915	100.0	29 879	100.0	19 801	100.0	-2 036	100.0	1 901	100.0
Other mining (including mining services)												
Reporting corporations												
Canadian	5 124	97.1	8 523	74.8	3 846	75.2	4 075	76.4	-441	81.4	186	60.8
Foreign	152	2.9	2 876	25.2	1 267	24.8	1 262	23.6	-101	18.6	120	39.2
Total	5 276	100.0	11 399	100.0	5 113	100.0	5 337	100.0	-542	100.0	306	100.0
Total mining												
Reporting corporations												
Canadian	7 639	95.0	78 389	68.9	31 841	65.9	20 584	59.5	-3 529	163.9	902	36.7
Foreign	402	5.0	35 354	31.1	16 485	34.1	14 014	40.5	1 376	-63.9	1 557	63.3
Total	8 041	100.0	113 743	100.0	48 326	100.0	34 598	100.0	-2 153	100.0	2 459	100.0

[1] Cement, lime and clay products (domestic clay) are included in mineral manufacturing industries. [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

p Preliminary.

Note: Totals may not add due to rounding.

TABLE 79. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINERAL MANUFACTURING INDUSTRIES[1] BY DEGREE OF NON–RESIDENT OWNERSHIP, 1985r

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Primary metal products												
Reporting corporations												
Canadian	386	90.4	14 291	80.5	6 162	84.2	11 879	83.2	90	54.5	368	79.5
Foreign	41	9.6	3 457	19.5	1 158	15.8	2 396	16.8	75	45.5	95	20.5
Total	427	100.0	17 748	100.0	7 320	100.0	14 275	100.0	165	100.0	463	100.0
Nonmetallic mineral products												
Reporting corporations												
Canadian	1 541	95.4	2 351	28.6	926	21.9	3 000	44.3	211	28.0	189	39.2
Foreign	74	4.6	5 856	71.4	3 303	78.1	3 769	55.7	543	72.0	293	60.8
Total	1 615	100.0	8 207	100.0	4 229	100.0	6 769	100.0	754	100.0	482	100.0
Petroleum and coal products												
Reporting corporations												
Canadian	111	82.8	22 816	58.5	9 031	48.4	16 589	44.7	418	26.4	554	64.8
Foreign	23	17.2	16 218	41.5	9 621	51.6	20 500	55.3	1 166	73.6	301	35.2
Total	134	100.0	39 034	100.0	18 652	100.0	37 089	100.0	1 584	100.0	855	100.0
Total mineral manufacturing industries												
Reporting corporations												
Canadian	2 038	93.7	39 458	60.7	16 119	53.4	31 468	54.1	719	28.7	1 111	61.7
Foreign	138	6.3	25 531	39.3	14 082	46.6	26 665	45.9	1 784	71.3	689	38.3
Total	2 176	100.0	64 989	100.0	30 201	100.0	58 133	100.0	2 503	100.0	1 800	100.0

[1] Includes cement, lime and clay products (domestic clay). [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non–residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid–up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

r Revised

Note: Totals may not add due to rounding.

TABLE 79a. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN THE MINERAL MANUFACTURING INDUSTRIES[1] BY DEGREE OF NON-RESIDENT OWNERSHIP, 1986p

	Corporations[2]		Assets[3]		Equity[4]		Sales[5]		Profits[6]		Taxable Income[7]	
	(number)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)	($ million)	(%)
Primary metal products												
Reporting corporations												
Canadian	411	92.6	14 669	80.1	6 734	86.1	11 901	82.5	584	80.9	260	66.0
Foreign	33	7.4	3 635	19.9	1 083	13.9	2 530	17.5	138	19.1	134	34.0
Total	444	100.0	18 304	100.0	7 817	100.0	14 431	100.0	722	100.0	394	100.0
Nonmetallic mineral products												
Reporting corporations												
Canadian	1 535	95.3	2 510	32.3	990	28.9	3 268	47.9	275	52.5	252	40.6
Foreign	75	4.7	5 272	67.7	2 434	71.1	3 557	52.1	249	47.5	369	59.4
Total	1 610	100.0	7 782	100.0	3 424	100.0	6 825	100.0	524	100.0	621	100.0
Petroleum and coal products												
Reporting corporations												
Canadian	110	82.7	18 205	47.3	8 796	41.1	9 510	33.3	2 474	63.8	209	27.4
Foreign	23	17.3	20 263	52.7	12 614	58.9	19 026	66.7	1 401	36.2	554	72.6
Total	133	100.0	38 468	100.0	21 410	100.0	28 536	100.0	3 875	100.0	763	100.0
Total mineral manufacturing industries												
Reporting corporations												
Canadian	2 056	94.0	35 384	54.8	16 520	50.6	24 679	49.6	3 333	65.1	721	40.6
Foreign	131	6.0	29 170	45.2	16 131	49.4	25 113	50.4	1 788	34.9	1 057	59.4
Total	2 187	100.0	64 554	100.0	32 651	100.0	49 792	100.0	5 121	100.0	1 778	100.0

[1] Includes cement, lime and clay products (domestic clay). [2] Corporations reporting under the Corporations and Labour Unions Returns Act. A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled. Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership. [3] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets. The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation. [4] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus. [5] For nonfinancial corporations, sales are gross revenues from nonfinancial operations. For financial corporations, sales include income from financial as well as nonfinancial sources. [6] The net earnings from operations, investment income and net capital gains. Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends. [7] Taxable income figures are as reported by corporations prior to assessment by the Department of National Revenue. They include earnings in the reference year after the deduction of applicable losses of other years.

p Preliminary.

Note: Totals may not add due to rounding.

TABLE 80. CANADA, FINANCIAL STATISTICS OF CORPORATIONS IN NONFINANCIAL INDUSTRIES BY MAJOR INDUSTRY GROUP AND BY CONTROL, 1985 AND 1986

	Agriculture, Forestry, Fishing and Trapping		Mines, Quarries and Oil Wells		Manufacturing		Construction		Transportation, Communication and Other Utilities		Trade		Services		Total	
	1985	1986p	1985	1986p	1985	1986p	1985	1986p	1985	1986p	1985	1986p	1985	1986p	1985	1986p
								(number)								
Corporations[1]																
Canadian Control	23 293	23 842	7 557	7 639	40 792	41 384	60 150	62 046	25 105	26 208	136 339	138 995	123 293	128 328	416 529	428 442
Foreign Control	83	80	449	402	1 899	1 777	145	145	265	237	1 745	1 624	672	597	5 258	4 862
Total	23 376	23 922	8 006	8 041	42 691	43 161	60 295	62 191	25 370	26 445	138 084	140 619	123 965	128 925	421 787	433 304
								($ million)								
Assets[2]																
Canadian Control	12 333	13 043	82 316	78 389	127 051	130 204	20 668	22 933	175 495	183 700	92 536	101 682	43 644	47 181	554 043	577 132
Foreign Control	430	395	39 675	35 354	90 517	101 314	1 800	1 746	6 139	5 906	23 255	24 620	7 716	9 079	169 532	178 414
Total	12 763	13 438	121 991	113 743	217 568	231 518	22 468	24 679	181 634	189 606	115 791	126 302	51 360	56 260	723 575	755 546
Equity[3]																
Canadian Control	4 317	4 705	34 061	31 841	48 738	53 540	4 934	5 801	47 895	49 974	26 716	30 789	10 616	11 943	177 277	188 593
Foreign Control	179	219	18 382	16 486	46 843	52 022	652	679	2 165	2 293	8 221	9 401	3 182	4 009	79 624	85 109
Total	4 495	4 924	52 443	48 327	95 581	105 562	5 586	6 480	50 060	52 267	34 937	40 190	13 798	15 952	256 901	273 702
Sales[4]																
Canadian Control	9 652	10 066	24 876	20 583	148 312	150 337	38 950	45 216	79 679	81 095	229 934	250 617	49 278	53 473	580 681	611 387
Foreign Control	280	246	23 556	14 013	140 585	144 636	2 862	2 753	4 565	4 513	56 244	57 458	8 440	8 949	236 532	232 568
Total	9 932	10 312	48 432	34 596	288 897	294 973	41 812	47 969	84 244	85 608	286 178	308 075	57 718	62 422	817 213	843 955
Profits[5]																
Canadian Control	475	560	3 116	-3 529	5 470	9 804	1 292	1 575	5 175	5 714	7 203	8 277	3 350	3 486	26 081	25 887
Foreign Control	51	31	6 297	1 376	8 900	9 455	81	79	573	617	1 514	1 925	1 001	988	18 417	14 471
Total	526	591	9 413	-2 153	14 370	19 259	1 373	1 654	5 748	6 331	8 717	10 202	4 351	4 474	44 498	40 358

[1] Corporations reporting under the Corporations and Labour Unions Returns Act A corporation is considered to be foreign controlled if 50% or more of its voting rights are known to be held outside Canada, and/or by one or more Canadian corporations which are, in turn, foreign controlled Each corporation is classified according to the percentage of its voting rights which are owned by non-residents, either directly or through other Canadian corporations, and the whole of the corporation is assigned to this particular degree of foreign ownership [2] Included are cash, marketable securities, accounts receivable, inventories, fixed assets, investments in affiliated corporations and other assets The amounts tabulated are those shown on the balance sheets of corporations after deducting allowances for doubtful accounts, amortization, depletion and depreciation [3] Equity represents the shareholders' interest in the net assets of the corporation and includes the total amount of all issued and paid-up share capital, earnings retained in the business and other surplus accounts such as contributed and capital surplus [4] For nonfinancial corporations, sales are gross revenues from nonfinancial operations For financial corporations, sales include income from financial as well as nonfinancial sources [5] The net earnings from operations, investment income and net capital gains Profits are tabulated after deducting allowances for amortization, depletion and depreciation, but before income tax provisions or declaration of dividends

p Preliminary

Note Totals may not add due to rounding

TABLE 81. CANADA, CAPITAL AND REPAIR EXPENDITURES BY SELECTED INDUSTRIAL SECTOR, 1987–89

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
						($ million)				
Agriculture	1987	1 037.1	1 885.2	2 922.3	430.4	1 342.9	1 773.3	1 467.5	3 228.1	4 695.6
	1988^p	1 148.0	1 988.8	3 136.8	452.2	1 375.7	1 827.9	1 600.2	3 364.5	4 964.7
	1989^i	1 213.7^r	2 141.0^r	3 354.7^r	482.0	1 497.4	1 979.4	1 695.7^r	3 638.4^r	5 334.1^r
Construction	1987	313.6	1 269.4	1 583.0	59.9	919.8	979.7	373.5	2 189.2	2 562.7
	1988^p	350.8	1 488.5	1 839.3	64.4	1 072.1	1 136.5	415.2	2 560.6	2 975.8
	1989^i	396.9^r	1 684.2^r	2 081.1^r	69.0	1 147.4	1 216.4	465.9^r	2 831.6^r	3 297.5^r
Forestry	1987	104.3	142.9	247.2	60.7	255.2	315.9	165.0	398.1	563.1
	1988^p	130.5	143.6	274.1	84.9	249.5	334.4	215.4	393.1	608.5
	1989^i	144.8^r	164.2^r	309.0^r	91.1	247.8	338.9	235.9^r	412.0^r	647.9^r
Housing	1987	32 519.4	–	32 519.4	3 305.9	–	3 305.9	35 825.3	–	35 825.3
	1988^p	35 244.2	–	35 244.2	3 415.4	–	3 415.4	38 659.6	–	38 659.6
	1989^i	37 010.3^r	–	37 010.3^r	3 631.0	–	3 631.0	40 641.3^r	–	40 641.3^r
Manufacturing	1987	2 812.4	12 519.2	15 331.6	949.3	6 339.5	7 288.8	3 761.7	18 858.7	22 620.4
	1988^p	3 079.4	14 536.6	17 616.0	1 013.8	6 616.8	7 630.6	4 093.2	21 153.4	25 246.6
	1989^i	3 823.8^r	18 710.4^r	22 534.2^r	1 083.3	6 956.0	8 039.3	4 907.1^r	25 666.4^r	30 573.5^r
Mining[1]	1987	5 845.9	1 130.3	6 976.2	440.0	2 163.5	2 603.5	6 285.9	3 293.8	9 579.7
	1988^p	7 048.1	1 435.3	8 483.4	392.2	2 362.1	2 754.3	7 440.3	3 797.4	11 237.7
	1989^i	6 332.0^r	1 167.3^r	7 499.3^r	436.9	2 459.3	2 896.2	6 768.9^r	3 626.6^r	10 395.5^r
Trade	1987	875.3	2 032.2	2 907.5	343.3	455.1	798.4	1 218.6	2 487.3	3 705.9
	1988^p	938.1	2 184.0	3 122.1	343.5	465.7	809.2	1 281.6	2 649.7	3 931.3
	1989^i	1 122.9^r	2 415.4^r	3 538.3^r	363.7	475.7	839.4	1 486.6^r	2 891.1^r	4 377.7^r
Utilities	1987	6 815.2	7 532.8	14 348.0	2 055.6	5 550.7	7 606.3	8 870.8	13 083.5	21 954.3
	1988^p	8 518.6	9 594.3	18 112.9	2 129.4	5 608.5	7 737.9	10 648.0	15 202.8	25 850.8
	1989^i	10 481.9^r	10 735.3^r	21 217.2^r	2 248.4	5 864.5	8 112.9	12 730.3^r	16 599.8^r	29 330.1^r
Other[2]	1987	19 597.8	12 729.4	32 327.2	4 404.3	1 946.5	6 350.8	24 002.1	14 675.9	38 678.0
	1988^p	21 594.3	13 740.5	35 334.8	4 765.5	2 014.6	6 780.1	26 359.8	15 755.1	42 114.9
	1989^i	24 156.7^r	15 161.2^r	39 317.9^r	4 944.8	2 106.5	7 051.3	29 101.5^r	17 267.7^r	46 369.2^r
Total	1987	69 921.0	39 241.4	109 162.4	12 049.4	18 973.2	31 022.6	81 970.4	58 214.6	140 185.0
	1988^p	78 052.0	45 111.6	123 163.6	12 661.3	19 765.0	32 426.3	90 713.3	64 876.6	155 589.9
	1989^i	84 683.0^r	52 179.0^r	136 862.0^r	13 350.2	20 754.6	34 104.8	98 033.2^r	72 933.6^r	170 966.8^r
Mining as a percentage of total	1987	8.4	2.9	6.4	3.7	11.4	8.4	7.7	5.7	6.8
	1988^p	9.0	3.2	6.9	3.1	12.0	8.5	8.2	5.9	7.2
	1989^i	7.5^r	2.2^r	5.5^r	3.3	11.8	8.5	6.9^r	5.0^r	6.1^r

[1] Includes mines, quarries and oil wells. [2] Includes finance, real estate, insurance, commercial services, institutions and government departments.

^{p} Preliminary; ^{i} Intentions; – Nil; ^{r} Revised

Note: Totals may not add due to rounding

TABLE 82. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] BY GEOGRAPHICAL REGION, 1987–89

		Capital Expenditures			Repair Expenditures			Capital and Repair Expenditures		
		Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total	Construction	Machinery and Equipment	Total
		($ million)								
Atlantic Region	1987	469.8	107.1	576.9	16.8	216.9	233.7	486.6	324.0	810.6
	1988^{p}	409.4	108.5	517.9	16.0	231.7	247.7	425.4	340.2	765.6
	1989^{i}	273.3^{r}	147.5^{r}	420.8^{r}	17.5	226.5	244.0	290.8^{r}	374.0^{r}	664.8^{r}
Quebec	1987	315.5	109.6	425.1	36.8	210.5	247.3	352.3	320.1	672.4
	1988^{p}	260.8	94.3	355.1	27.1	222.4	249.5	287.9	316.7	604.6
	1989^{i}	292.1^{r}	114.6^{r}	406.7^{r}	25.6	237.8	263.4	317.7^{r}	352.4^{r}	670.1^{r}
Ontario	1987	618.4	189.2	807.6	46.6	357.9	404.5	665.0	547.1	1 212.1
	1988^{p}	562.0	335.6	897.6	69.3	416.3	485.6	631.3	751.9	1 383.2
	1989^{i}	471.7^{r}	263.3^{r}	735.0^{r}	74.0	446.0	520.0	545.7^{r}	709.3^{r}	1 255.0^{r}
Prairie Region	1987	3 624.3	589.1	4 213.4	304.6	905.3	1 209.9	3 928.9	1 494.4	5 423.3
	1988^{p}	4 762.5	754.1	5 516.6	240.5	997.9	1 238.4	5 003.0	1 752.0	6 755.0
	1989^{i}	4 250.7^{r}	406.8^{r}	4 657.5^{r}	269.2	1 051.8	1 321.0	4 519.9^{r}	1 458.6^{r}	5 978.5^{r}
British Columbia	1987	533.2	118.1	651.3	32.3	408.2	440.5	565.5	526.3	1 091.8
	1988^{p}	740.5	96.0	836.5	37.2	448.8	486.0	777.7	544.8	1 322.5
	1989^{i}	744.1^{r}	186.2^{r}	930.3^{r}	48.5	456.2	504.7	792.6^{r}	642.4^{r}	1 435.0^{r}
Yukon and Northwest Territories	1987	284.7	17.2	301.9	2.9	64.7	67.6	287.6	81.9	369.5
	1988^{p}	312.9	46.8	359.7	2.1	45.0	47.1	315.0	91.8	406.8
	1989^{i}	300.1^{r}	48.9^{r}	349.0^{r}	2.1	41.0	43.1	302.2^{r}	89.9^{r}	392.1^{r}
Canada, total	1987	5 845.9	1 130.3	6 976.2	440.0	2 163.5	2 603.5	6 285.9	3 293.8	9 579.7
	1988^{p}	7 048.1	1 435.3	8 483.4	392.2	2 362.1	2 754.3	7 440.3	3 797.4	11 237.7
	1989^{i}	6 332.0^{r}	1 167.3^{r}	7 499.3^{r}	436.9	2 459.3	2 896.2	6 768.9^{r}	3 626.6^{r}	10 395.5^{r}

[1] Includes mines, quarries and oil wells.

^{p} Preliminary; ^{i} Intentions; ^{r} Revised

Note: Totals may not add due to rounding.

TABLE 83. CANADA, CAPITAL AND REPAIR EXPENDITURES IN MINING[1] AND MINERAL MANUFACTURING INDUSTRIES, 1987–89

	1987			1988^{p}			1989^{i}		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Mining Industry									
Metal mines									
Copper-gold-silver	219.2	266.4	485.6	342.7	266.0	608.7	294.8^{r}	283.5	578.3^{r}
Gold	920.0	143.8	1 063.8	1 000.2	214.2	1 214.4	727.2^{r}	225.2	952.4^{r}
Iron	120.4	200.6	321.0	98.8	229.4	328.2	108.1^{r}	211.0	319.1^{r}
Silver-lead-zinc	130.8	113.6	244.4	114.5	101.7	216.2	212.4^{r}	102.7	315.1^{r}
Other metal mines	310.7	266.2	576.9	344.1	312.6	656.7	451.7^{r}	343.3	795.0^{r}
Total metal mines	1 701.1	990.6	2 691.7	1 900.3	1 123.9	3 024.2	1 794.2^{r}	1 165.7	2 959.9^{r}
Nonmetal mines									
Asbestos	55.3	55.0	110.3	39.0	56.1	95.1	37.5^{r}	59.8	97.3^{r}
Other nonmetal mines[2]	618.0	577.0	1 195.0	603.8	571.8	1 175.6	624.2^{r}	583.3	1 207.5^{r}
Total nonmetal mines	673.3	632.0	1 305.3	642.8	627.9	1 270.7	661.7^{r}	643.1	1 304.8^{r}
Mineral fuels									
Petroleum and gas[3]	4 601.8	980.9	5 582.7	5 940.3	1 002.5	6 942.8	5 043.4^{r}	1 087.4	6 130.8^{r}
Total mining industries	6 976.2	2 603.5	9 579.7	8 483.4	2 754.3	11 237.7	7 499.3^{r}	2 896.2	10 395.5^{r}
Mineral Manufacturing									
Primary metal industries									
Aluminum rolling, casting and extruding	65.5	54.9	120.4	80.8	62.0	142.8	125.9^{e}	61.2	187.1^{e}
Copper and copper alloy, rolling, casting and extruding	13.6	13.1	26.7	6.1	14.2	20.3	7.7^{e}	14.4	22.1^{e}
Iron and steel mills	757.1	851.9	1 609.0	523.0	934.9	1 457.9	796.3^{e}	1 000.1	1 796.4^{e}
Iron foundries	56.1	67.4	123.5	35.3	59.0	94.3	54.1^{e}	62.3	116.4^{e}
Metal rolling, casting and extruding	31.3	19.3	50.6	15.9	19.4	35.3	20.8^{e}	18.1	38.9^{e}
Smelting and refining	515.3	456.7	972.0	839.4	541.7	1 381.1	1 425.2^{e}	550.7	1 975.9^{e}
Steel pipe and tube mills	50.0	65.1	115.1	30.2	71.5	101.7	77.4^{e}	67.4	144.8^{e}
Total primary metal industries	1 488.9	1 528.4	3 017.3	1 530.7	1 702.7	3 233.4	2 507.5^{r}	1 774.2	4 281.7^{r}

TABLE 83. (cont'd)

	1987			1988[p]			1989[i]		
	Capital	Repair	Total	Capital	Repair	Total	Capital	Repair	Total
					($ million)				
Nonmetallic mineral products									
Abrasives	7.5	11.7	19.2	9.6	13.0	22.6	8.2[e]	13.4	21.6[e]
Cement	39.9	91.4	131.3	92.7	94.7	187.4	224.1[e]	94.6	318.7[e]
Clay products	53.5	7.4	60.9	22.9	9.2	32.1	16.1[e]	10.3	26.4[e]
Concrete products	39.5	35.7	75.2	57.7	31.9	89.6	60.4[e]	33.7	94.1[e]
Glass and glass products	96.8	31.0	127.8	84.8	31.5	116.3	133.9[e]	27.0	160.9[e]
Lime	4.9	6.1	11.0	12.7	6.5	19.2	22.8[e]	7.3	30.1[e]
Ready-mix concrete	66.9	59.1	126.0	76.3	53.7	130.0	100.2[e]	52.8	153.0[e]
Stone products	6.9	0.5	7.4	2.0	1.4	3.4	2.5[e]	1.4	3.9[e]
Other nonmetallic mineral products	40.2	57.9	98.1	85.3	63.2	148.5	106.9[e]	64.8	171.7[e]
Total nonmetallic mineral products	356.1	300.8	656.9	444.0	305.1	749.1	675.0[r]	305.3	980.3[r]
Petroleum and coal products									
Petroleum refineries	660.0	349.5	1 009.5	694.7	364.0	1 058.7	838.8[e]	419.8	1 258.6[e]
Petroleum and coal products	9.9	16.1	26.0	14.2	15.2	29.4	12.8[e]	15.5	28.3[e]
Total petroleum and coal products	669.9	365.6	1 035.5	708.9	379.2	1 088.1	851.6[r]	435.3	1 286.9[r]
Total mineral manufacturing industries	2 514.9	2 194.8	4 709.7	2 683.6	2 387.0	5 070.6	4 034.1[r]	2 514.8	6 548.9[r]
Total mining and mineral manufacturing industries	9 491.1	4 798.3	14 289.4	11 167.0	5 141.3	16 308.3	11 533.4[r]	5 411.0	16 944.4[r]

[1] Does not include cement, lime and clay products (domestic clay) manufacturing, smelting and refining. [2] Includes coal mines, gypsum, salt, potash and miscellaneous nonmetal mines and quarrying. [3] The total of capital expenditures shown under "petroleum and gas" is equal to the total capital expenditure under the columns entitled "petroleum and natural gas extraction," "natural gas processing plants" and "oil and gas drilling contractors" of Table 86.

[p] Preliminary; [i] Intentions; [r] Revised; [e] Estimated.

Note: Totals may not add due to rounding.

TABLE 84. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINING INDUSTRY[1], 1983–89

	1983	1984	1985	1986	1987	1988^{p}	1989^{i}
				($ million)			
Metal Mines							
Capital							
Construction	839.1	942.2	1 053.5	979.7	1 328.2	1 361.6	1 247.4^{r}
Machinery	312.0	372.7	322.4	319.4	372.9	538.7	546.8^{r}
Total	1 151.1	1 314.9	1 375.9	1 299.1	1 701.1	1 900.3	1 794.2^{r}
Repair							
Construction	93.3	99.6	104.5	99.6	109.8	120.1	128.2
Machinery	728.0	861.1	846.4	811.3	880.8	1 003.8	1 037.5
Total	821.3	960.7	950.9	910.9	990.6	1 123.9	1 165.7
Total capital and repair	1 972.4	2 275.6	2 326.8	2 210.0	2 691.7	3 024.2	2 959.9^{r}
Nonmetal Mines[2]							
Capital							
Construction	1 123.3	658.6	573.6	502.4	421.7	379.0	350.4^{r}
Machinery	433.9	571.7	350.1	256.6	251.6	263.8	311.3^{r}
Total	1 557.2	1 230.3	923.7	759.0	673.3	642.8	661.7^{r}
Repair							
Construction	25.5	47.2	39.3	31.2	23.2	26.2	31.0
Machinery	401.5	454.8	529.5	565.4	608.8	601.7	612.1
Total	427.0	502.0	568.8	596.6	632.0	627.9	643.1
Total capital and repair	1 984.2	1 732.3	1 492.5	1 355.6	1 305.3	1 270.7	1 304.8^{r}
Mineral Fuels							
Capital							
Construction	6 034.1	6 643.5	7 645.9	5 142.4	4 096.0	5 307.5	4 734.2^{r}
Machinery	880.6	686.7	959.7	496.4	505.8	632.8	309.2^{r}
Total	6 914.7	7 330.2	8 605.6	5 638.8	4 601.8	5 940.3	5 043.4^{r}
Repair							
Construction	427.4	283.4	374.3	316.5	307.0	245.9	277.7
Machinery	656.7	709.5	761.3	705.5	673.9	756.6	809.7
Total	1 084.1	992.9	1 135.6	1 022.0	980.9	1 002.5	1 087.4
Total capital and repair	7 998.8	8 323.1	9 741.2	6 660.8	5 582.7	6 942.8	6 130.8^{r}
Total Mining							
Capital							
Construction	7 996.5	8 244.3	9 273.0	6 624.5	5 845.9	7 048.1	6 332.0^{r}
Machinery	1 626.5	1 631.1	1 632.2	1 072.4	1 130.3	1 435.3	1 167.3^{r}
Total	9 623.0	9 875.4	10 905.2	7 696.9	6 976.2	8 483.4	7 499.3^{r}
Repair							
Construction	546.2	430.2	518.1	447.3	440.0	392.2	436.9
Machinery	1 786.2	2 025.4	2 137.2	2 082.2	2 163.5	2 362.1	2 459.3
Total	2 332.4	2 455.6	2 655.3	2 529.5	2 603.5	2 754.3	2 896.2
Total capital and repair	11 955.4	12 331.0	13 560.5	10 226.4	9 579.7	11 237.7	10 395.5^{r}

[1] Does not include cement, lime and clay products (domestic clays) manufacturing, smelting and refining. [2] Includes coal mines, asbestos, gypsum, salt, potash, miscellaneous nonmetals, quarrying and sand pits.

^{p} Preliminary; ^{i} Intentions; ^{r} Revised

Note: Totals may not add due to rounding.

TABLE 85. CANADA, CAPITAL AND REPAIR EXPENDITURES IN THE MINERAL MANUFACTURING INDUSTRIES, 1983–89

	1983	1984	1985	1986	1987	1988[p]	1989[i]
				($ million)			
Primary Metal Industries[1]							
Capital							
Construction	112.5	318.6	593.8	400.2	265.7	253.5	593.6[r]
Machinery	550.6	712.6	1 019.0	1 333.6	1 223.2	1 277.2	1 913.9[r]
Total	663.1	1 031.2	1 612.8	1 733.8	1 488.9	1 530.7	2 507.5[r]
Repair							
Construction	111.4	119.6	125.2	126.9	119.0	148.9	157.4
Machinery	1 053.1	1 215.7	1 231.1	1 279.0	1 409.4	1 553.8	1 616.8
Total	1 164.5	1 335.3	1 356.3	1 405.9	1 528.4	1 702.7	1 774.2
Total capital and repair	1 827.6	2 366.5	2 969.1	3 139.7	3 017.3	3 233.4	4 281.7[r]
Nonmetallic Mineral Products[2]							
Capital							
Construction	14.8	26.6	39.2	36.0	73.5	84.1	125.4[r]
Machinery	125.5	151.0	193.2	295.1	282.6	359.9	549.6[r]
Total	140.3	177.6	232.4	331.1	356.1	444.0	675.0[r]
Repair							
Construction	20.7	26.3	21.2	24.7	23.3	20.8	21.2
Machinery	204.1	236.5	270.6	285.7	277.5	284.3	284.1
Total	224.8	262.8	291.8	310.4	300.8	305.1	305.3
Total capital and repair	365.1	440.4	524.2	641.5	656.9	749.1	980.3[r]
Petroleum and Coal Products							
Capital							
Construction	629.6	321.4	248.3	272.3	464.9	466.8	576.8[r]
Machinery	211.2	111.0	87.4	125.9	205.0	242.1	274.8[r]
Total	840.8	432.4	335.7	398.2	669.9	708.9	851.6[r]
Repair							
Construction	196.0	230.3	213.0	212.0	252.8	260.9	303.1
Machinery	68.6	79.3	74.9	91.9	112.8	118.3	132.2
Total	264.6	309.6	287.9	303.9	365.6	379.2	435.3
Total capital and repair	1 105.4	742.0	623.6	702.1	1 035.5	1 088.1	1 286.9[r]
Total Mineral Manufacturing Industries							
Capital							
Construction	756.9	666.6	881.3	708.5	804.1	804.4	1 295.8[r]
Machinery	887.3	974.6	1 299.6	1 754.6	1 710.8	1 879.2	2 738.3[r]
Total	1 644.2	1 641.2	2 180.9	2 463.1	2 514.9	2 683.6	4 034.1[r]
Repair							
Construction	328.1	376.2	359.4	363.6	395.1	430.6	481.7
Machinery	1 325.8	1 531.5	1 576.6	1 656.6	1 799.7	1 956.4	2 033.1
Total	1 653.9	1 907.7	1 936.0	2 020.2	2 194.8	2 387.0	2 514.8
Total capital and repair	3 298.1	3 548.9	4 116.9	4 483.3	4 709.7	5 070.6	6 548.9[r]

[1] Includes smelting and refining. [2] Includes cement, lime and clay products manufacturing.
[p] Preliminary; [i] Intentions; [r] Revised.
Note: Totals may not add due to rounding.

TABLE 86. CANADA, CAPITAL EXPENDITURES IN THE PETROLEUM, NATURAL GAS AND ALLIED INDUSTRIES[1], 1981–89

	Petroleum and Natural Gas Extraction	Transportation (Pipelines)	Marketing (Chiefly Outlets of Oil Companies)	Natural Gas Distribution	Petroleum and Coal Products Industries	Natural Gas Processing Plants	Oil and Gas Drilling Contractors	Total Capital Expenditures
				($ million)				
1981	6 444.9	1 745.7	264.1	408.7	844.9	311.6	274.9	10 294.8
1982	6 743.4	1 994.3	320.5	517.6	1 224.5	522.8	173.5	11 496.6
1983	6 563.5	660.5	374.5	516.8	840.8	195.8	155.4	9 307.3
1984	6 946.4	795.4	422.9	604.1	432.4	340.0	43.8	9 585.0
1985	8 187.6	664.2	356.8	603.5	335.7	337.7	80.1	10 565.6
1986	5 401.1	586.9	344.9	573.9	398.2	207.8	29.9	7 542.7
1987	4 414.6	503.0	412.4	571.8	669.9	174.1[r]	13.1[r]	6 758.9[r]
1988[p]	5 694.0	828.2	513.1	516.8	708.9	232.5[r]	13.9[r]	8 507.4[r]
1989[i]	4 634.4[r]	1 493.1[r]	512.4[r]	539.9[r]	851.6[r]	395.2[r]	14.0[r]	8 440.6[r]

[1] The petroleum and natural gas industries in this table include all companies engaged in whole or in part in oil and gas activities.

[p] Preliminary; [i] Intentions; [r] Revised.

Note: Totals may not add due to rounding.

TABLE 87. CANADA, TOTAL INTRAMURAL RESEARCH AND DEVELOPMENT EXPENDITURES FOR MINING–RELATED INDUSTRIES IN CURRENT AND CONSTANT (1981) DOLLARS, 1983–89

	1983	1984	1985	1986	1987	1988^p	1989^f
				($ million)			
Current Dollars							
Mining industry	92	115	119	90	76	86	88
Mines	43	48	51	52	47	53	59
Oil and gas wells	49	67	69	38	29	33	29
Mineral manufacturing	298	356	342	279	274	308	330
Ferrous primary metals	22	26	26	27	30	32	32
Nonferrous primary metals	82	95	92	88	111	125	130
Nonmetallic mineral products	10	17	19	16	15	14	16
Petroleum products	184	218	205	148	118	137	152
Metal fabricating	28	24	30	34	33	40	43
Constant Dollars							
Mining industry	81	98	99	72	59	65^r	62
Mines	38	40	42	41	37	40	42^r
Oil and gas wells	43	57	57	31	22	25	21^r
Mineral manufacturing	261	303	283	225	210	228	234^r
Ferrous primary metals	19	22	22	22	23	24	23^r
Nonferrous primary metals	72	81	76	71	85	92	92^r
Nonmetallic mineral products	9	14	16	13	11	11	11
Petroleum products	161	186	169	119	91	101	108^r
Metal fabricating	24	20	25	28	25	30	31

^{p} Preliminary; ^{f} Forecast; ^{r} Revised.
Note: Totals may not add due to rounding.

TABLE 88. CANADA, CURRENT AND CAPITAL INTRAMURAL RESEARCH AND DEVELOPMENT EXPENDITURES FOR MINING–RELATED INDUSTRIES, 1983–89

	1983	1984	1985	1986	1987	1988p	1989f
				($ million)			
Capital Expenditures							
Mining industry	21	21	27	11	7	9	11
Mines	5	5	4	8	4	4	7
Oil and gas wells	16	16	23	3	3	5	3
Mineral manufacturing	48	97	82	30	34	40	53
Ferrous primary metals	1	1	3	3	4	5	4
Nonferrous primary metals	5	9	5	7	15	12	13
Nonmetallic mineral products	1	6	6	3	2	1	2
Petroleum products	41	81	68	17	13	22	34
Metal fabricating	3	3	2	4	4	3	4
Current Expenditures							
Mining industry	71	94	92	79	69	77	77
Mines	38	43	47	44	43	49	52
Oil and gas wells	33	51	46	35	26	28	26
Mineral manufacturing	250	259	260	249	240	268	277
Ferrous primary metals	21	25	23	24	26	27	28
Nonferrous primary metals	77	86	87	81	96	113	117
Nonmetallic mineral products	9	11	13	13	13	13	14
Petroleum products	143	137	137	131	105	115	118
Metal fabricating	25	21	28	30	29	37	39
Total Expenditures							
Mining industry	92	115	119	90	76	86	88
Mines	43	48	51	52	47	53	59
Oil and gas wells	49	67	69	38	29	33	29
Mineral manufacturing	298	356	342	279	274	308	330
Ferrous primary metals	22	26	26	27	30	32	32
Nonferrous primary metals	82	95	92	88	111	125	130
Nonmetallic mineral products	10	17	19	16	15	14	16
Petroleum products	184	218	205	148	118	137	152
Metal fabricating	28	24	30	34	33	40	43

p Preliminary; f Forecast.
Note: Totals may not add due to rounding.